October 27, 1921

Engineering News-Record

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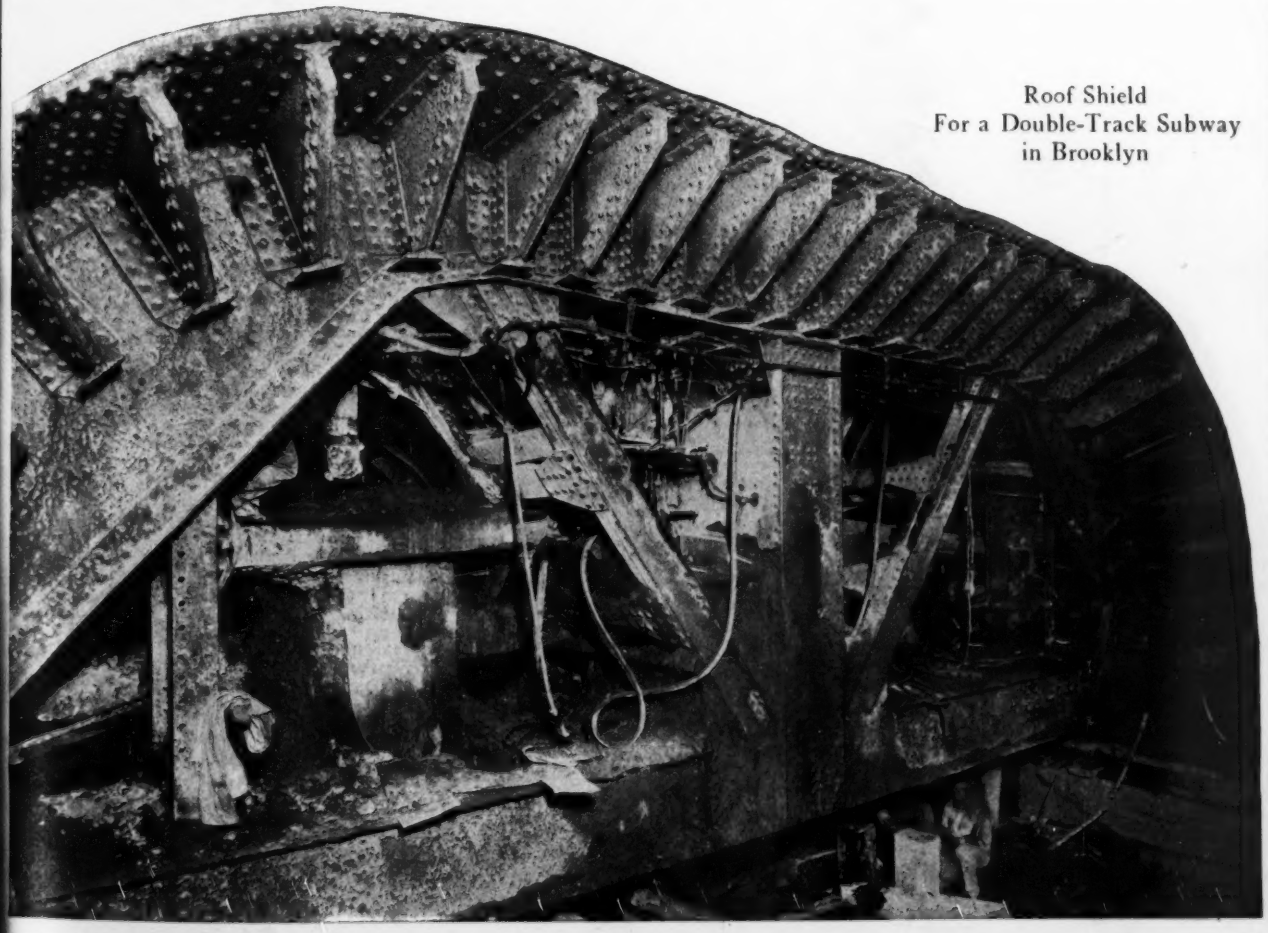
How Concrete Is Made with Large Aggregate in a California Dam

How to Handle Liquid Chlorine in Water Purification



Roof Shield
For a Double-Track Subway
in Brooklyn

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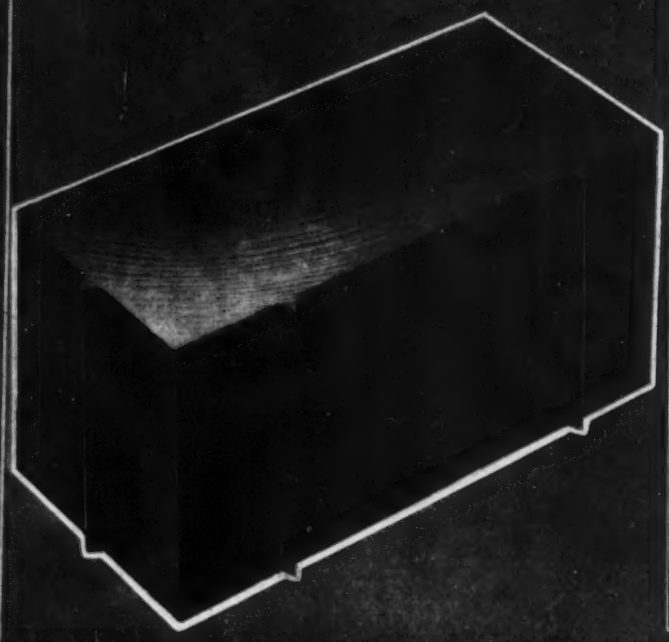

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ENGINEERING NEWS-RECORD

DEVOTED TO CIVIL ENGINEERING
AND CONTRACTING

E. J. MEHREN
Editor

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The Strike Situation

THE THREATENED railroad strike has met with the universal condemnation that was expected. Spurred by the public's attitude, the railroads are vigorously preparing for the maintenance of traffic while public officials are organizing to insure food and fuel supplies. The public condemnation and these firm preparations have probably had much to do in inducing the chiefs of railroad unions with a membership of 1,400,000 to refuse to join in the strike, despite the fact that favorable strike votes are in their possession. The action of the Railroad Labor Board, also, in calling the contending parties before it on Wednesday of this week was probably another factor that encouraged the split that has developed. The situation at the moment fully justifies the view expressed in these columns last week—that if the big brotherhoods are so foolish as to proceed with the strike, they will fail miserably. What is more, their hitherto great influence will probably be destroyed in their mad attempt.

Lack of Statesmanship

THE BLINDNESS of the labor leaders of this country passes all understanding. After a post-war experience during which they have seen their influence dwindle because of their unreasoning positions, they have failed to profit by the lesson. Their voices are raised constantly in favor of maintenance of peak war wages, but seldom or never are the chief officers heard trying to lead the men to sounder economic grounds by urging increase of production and abrogation of unreasonable and restrictive working agreements. Under statesmanlike leadership the labor movement could win invincible public support. Every man has sympathy with those whose lot in life is, apparently at least, the harder. With that advantage to start with the labor organizations could clinch public sympathy if they "played the game" in the best interests of the whole country. Nothing would make them stronger with the public and better able to carry their side in controversies than a position that would look primarily to public benefit rather than to their immediate personal gain. The leaders, however, lack the statesmanship to take such a stand.

Good Concrete With Big Stone

NOT OFTEN can the natural rock of the quarry be dug out, broken up and remixed into the artificial rock of concrete in so short a distance and under such favorable conditions as at the Barrett dam, described on another page. It is the very antithesis of central mixing with long-distance material feeding and long-distance concrete delivery, and it differs in the feeding end, at least, from practically all large concrete jobs where material has to be brought from a distance. Interest in the job, therefore, would be mainly in the solution of an unusual plant layout problem were it not for the use of large-size aggregate through the mixer and the exceptional care taken in the manufacture of the concrete. For mass work the opportunity for economy in big stone is great if equipment is made strong enough and big enough to carry the stone and to stand its wear. Mr. Savage has successfully used it before and apparently is doing so now; others who have similar conditions would do well to study the methods and results at the Barrett dam. It should be remembered, though, that with the large-size aggregate there is, on the Barrett job, an attention to the details of concrete-making common enough in the literature of concrete and in some building work, but all too rare on the big mass jobs.

Revival of Scientific Effort

SCIENTIFIC effort is reawakening in engineering, after a long period in which it was fairly dormant. Investigations like the British Ministry of Transport measurements of impact, the Indian tests in the same field, and the Swiss bridge experiments soon to be reported, are symptoms of such reawakening, the more significant because they represent a wide geographical range and people of different habits of mind. The rebirth of scientific thought has no local limitations, and evidently defines a new phase of engineering development, the forerunner of new progress. In our day-to-day thinking we are apt to look upon engineering as the work of building railroads, digging tunnels, or lifting great weights—the routine of practice, in other words. This is a natural view, even if not an inspiring one. Yet it is essentially false, by being incomplete. The engineer's life is more than a pick-and-shovel existence, and its best part, indeed, lies in the striving for progress; in trying to do a thing in a better way than was known before, or, perhaps, finding a way of doing a thing well enough so that it will be worth doing. That is the scientific element of engineering, and it is the life-giving element, since it stimulates and inspires in a way that the mere practice of the art can never match.

Great Opportunity Missed

ON MONDAY of last week there gathered in New York one of the most distinguished groups of engineers that has ever been brought together in this country. By reason of the fact that they were the present and past officers of the four leading national engineering societies, of Engineering Foundation, and of the Federated American Engineering Societies, they were the acclaimed chosen leaders of the engineering profession. They had been called together to welcome home the delegation which last summer presented the John Fritz medals to Sir Robert Hadfield and Eugene Schneider. It had been given out in advance that the meeting might be expected to be the occasion for launching some great agency for international understanding between engineers—at least between those of Great Britain, France, and the United States. Unfor-

tunately, the great opportunity was missed. There was fulsome praise of the spirit in which the Americans had been received in England and in France, but there was no adequate response to Sir Robert Hadfield's inspiring cable message urging the formation of a definite agency of understanding and co-operation. M. Schneider's message also implied the desirability of such an agency. With the inspiration of these messages, of the enthusiasm of a returning delegation and of an audience of most distinguished character, it was a time of times for raising engineering thought to a new plane, of showing that the Americans were capable of a response equivalent to the highmindedness of the messages from abroad. An evening that should have gone down as memorable among American engineering gatherings was, for lack of adequate planning, allowed to dwindle into one of the most cold and formal affairs we can recall. It must remain for another time to proceed with the launching of the agency proposed by our foreign friends and so sure to be endorsed by the profession in the United States.

Promoter Versus Engineer

MR. CABOT'S paper on the engineer's failure as a manager is, in our judgment, too severe with the engineer. There are engineers with vision; technical training has not universally destroyed or constricted a broad outlook. On the other hand, we do believe then he is correct in his contention that it is the promotional mind that is chiefly responsible for conspicuous success in large enterprises. There is, though, still another thought that deserves emphasis; it was overlooked both by Mr. Cabot and by those who attempted to answer him, namely, that the conduct of all great enterprises requires a variety of talent and of point of view for success. There is needed the men of vision. There are needed, also, though they may not get into the public eye, the cautious financier, the careful administrator, the efficient production manager, the capable engineer. It is, in fact, in recognition of the need for a variety of experience and view that the standard form of corporate management is through boards of directors and executive committees. Engineers should not contend that the engineering mind alone will be adequate for success in great projects. Nor should Mr. Cabot place exclusive stress on the promoter. Finally, while it would be dangerous for all engineers to have the promotional instinct it would be helpful to the profession if more of them had that fine combination of vision and courage which has produced our great enterprises.

Fall Highway Lettings

FROM the replies received to *Engineering News-Record's* inquiry regarding the fall letting of next season's highway contracts, published in this week's and last week's issues, it is evident that a substantial majority of the states not only favor the early award of road construction contracts, but are actually letting them now or are preparing to let them. Of the twenty-five answers received from state highway engineers, as this is written, fifteen announce definitely that either the entire 1922 road construction program or else as much as possible of it will be placed under contract before the first of the year. Some of the states not included in the foregoing category are handicapped by lack of funds and also by the fact that a number of the state legislatures do not meet until January, making it impossible to place work under contract until new supplies of money have been provided. A few of the states are opposed to awards this year in the belief that lower prices will be obtainable next spring, Maryland and Wisconsin being two of the leading states to follow this line of reasoning. Illinois, another big road-building state, while favoring the policy of fall lettings, qualifies its position in an analysis which concludes, in effect, that the proper time to let highway contracts, from the point of view of the state highway engineer, depends upon a combination of labor and material considerations rather than on seasonal conditions. Taken as a whole, the enunciation of policy by the state highway engineers furnishes a basis for a decidedly optimistic outlook for next year's road-building program. The clear evidence regarding the advance planning which state highway departments are doing is also encouraging.

The Biggest Business Conference

IN LESS than a month the disarmament conference—or, better, the conference on the limitation of armaments—will be in session in Washington. Most people look upon it as a gathering for the discussion of problems in international politics. As a matter of fact, it is the biggest business conference in many a day.

It is a business conference not merely because the limitation of armaments would turn billions of capital into productive, instead of destructive, directions, but because the China question, which will be discussed prior to disarmament, is chiefly a business matter. If a constructive and conserving program for China's future can be mapped out by unanimous consent, reduction of armaments will logically follow. The center of possible future world disturbance has been shifted from Central Europe to the Pacific.

Essentially the Chinese question is that of maintenance of the "open door," the right of all nations to trade in any part of China on an equal basis, to make investments there unaffected by the preferential interests of other nations. In short, it is a matter of determining on what basis American business men, as well as the business men of every other nation, shall be permitted to share in Chinese trade. Also, it is worth noting that the disarmament meeting as a business conference has an important class interest to engineers and contractors. They are the forerunners of intensive material development. They lay out the avenues of communication. Theirs is the task of making possible the living together, in a sanitary and comfortable way, of large aggregations of human beings. Theirs, then, is a primary interest in the outcome of the coming Washington meeting. Before extensive material development in China must come the civil engineer and the contractor.

A Strike With Novel Features

A STRIKE with two novel features is in progress in the Kern oil fields of California. In the first place, the strikers are perfectly willing to accept the wages and conditions of employment which the producers are willing to grant, but insist that the federal government shall underwrite the agreement for a period of a year. The second novel feature is that the strikers have organized upon military lines, with headquarters at Taft and divisional headquarters at six other points.

A motorcycle corps and emergency patrols are always in readiness to send reinforcements with the aim of preventing the introduction of strike breakers into the district. At the start these patrols were stationed upon all highways entering the oil district and were maintained night and day. Upon protest, however, of the secretary of the Governor of California these patrols were abandoned.

The strikers contend that their maintenance of a military form of organization is due entirely to the desire to prevent violence. Many of the officers of their "army" are constables and deputies under the authority of Kern County. The reports indicate, that while the army is very active and has been successful in preventing the introduction of strike breakers no violence has occurred.

Naturally, the oil producers are protesting at the breakdown of the public authority—or, rather, at its partisan use. In that protest, of course, they will be supported by all fairminded citizens. The situation is novel, to say the least, for in past strikes it has been the frequent charge of the striking employees that the military and police powers were used in favor of the employers. Whether justified or not the shoe in this case in on the other foot.

As to the demand of the strikers that the federal government underwrite the agreement, comment is hardly possible without knowing the full circumstances which have resulted in this extraordinary demand. On its face, and in the baldness with which it has been reported, it seems to go beyond all former measures of composing industrial difficulties. A federal sanction has, of course, been given in the past to industrial settlements, as in the case of the anthracite commission of the Roosevelt administration. That was, however, decidedly different from having the federal government guarantee the carrying out of an industrial compact.

Will of a Great Engineer

FOR reasons only too well known to most of our readers the last will and testament of an engineer is rarely of interest outside his family circle. An exception rare as to the sum total bequeathed and notable because of the beneficiaries named, the evident thought put upon their selection and the restrictions and explanations relating to the residuary estate, is afforded by the will of the late Hiram F. Mills, which has just been made public. Of the public bequests of specified amounts, two are outstanding because of their objects and conditions. A large cancer research fund bequeathed to Harvard University speaks volumes, coming as it does from a man who, through his thirty years of devoted work on the State Board of Health of Massachusetts, contributed so much to the reduction of the mortality rate in general and to the typhoid rate in particular. Some decades ago, it is conceivable that Mr. Mills might have established a fund to combat typhoid. That is no longer an urgent need. A fund to aid in the reduction of the general death rate would not have that directness of aim to be expected from an engineer like Mr. Mills. What more natural, familiar as he was with the major causes of disease, suffering, and death, still awaiting successful attack, than that Mr. Mills should select that wide-spread. baffling and dreaded disease, cancer?

The minor public bequests, it may be noted in passing, show discrimination. The gifts are small but they will prove helpful—materially and, in some respects more important yet, because of the appreciative recognition given to these institutions in the will of a great and thoughtful engineer.

Most directly human of all the gifts, and perhaps most characteristic of the giver, is the bequest of the residue of Mr. Mills' estate for the benefit of the needy of Lawrence and Lowell, particularly the mill workers. This gift, as stated in the will, springs from Mr. Mills' half century of professional work in making the most of the water-power on the Merrimac and upbuilding the cities of Lawrence and Lowell. The gift shows an appreciation of the human as well as the mechanical factor in the growth of these communities.

Mr. Mills' bequests prove anew that a man's deeds are his best monument. They also show that a last will and testament may be the most self revealing of the documents a man leaves among the written memorials of his life work and his deepest and most heart-felt aspirations.

Fighting a Unified Port

THERE is evidently trouble ahead for the Port of New York Authority. By law of the States of New Jersey and New York, confirmed by a federal act, an interstate Port Authority has been created. Before next January this body must submit to the two state legislatures a comprehensive plan for the physical development of the district, on the acceptance of which the Authority will really begin to function as a sovereign body subject to law but not to any local or state control.

It is expressly provided, however, that "no city within the port district shall be bound by the comprehensive plan unless and until it has approved the same." The present city administration of New York has consistently fought the idea of joint control of the port, and though step by step it has been beaten in the legislative fight, it is apparently still in the ring. The report of the special committee on the Brooklyn-Richmond freight and passenger tunnel, noted in the news columns this week, is new evidence of that fact. This lengthy report, filled with figures and maps, mentions only twice the Port Authority and those two references are merely an acknowledgement of statistical data. Yet the report which they render is merely another solution of the belt-line problem fully discussed in the elaborate report of the New York, New Jersey Port and Harbor Development Commission and which undoubtedly will form a major part of the proposed "comprehensive" plan to be presented by the Authority in a few months. Starting from the isolated authorization of a passenger and freight tunnel across the Narrows, the Board of Estimate's committee has built up an elaborate study of the entire freight problem of the port of New York.

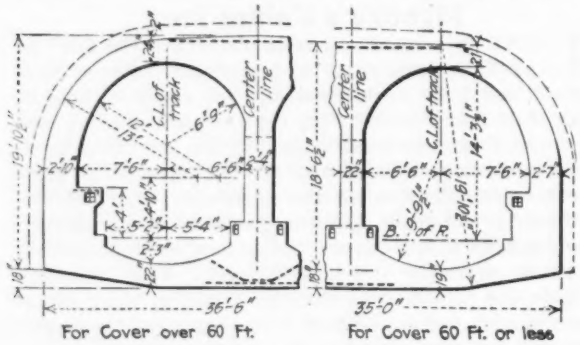
It is not our purpose here to discuss the relative merits of the committee's plan and the plan of the Port Authority, or to advocate one over the other. It is our desire to condemn the obstructionist policy of the city of New York in the development of the port. A proper method of dealing with the problems of the port has been provided in the Port Authority. The city has its rights and privileges fully guarded in the new treaty. Why does it not deal with the problem in the properly constituted manner instead of proceeding along its own lines independently and evidently with full intent of throwing as many monkey wrenches into the machinery of the port's development as it legally can?

Timbered and Roof-Shield Tunneling in Deep Loose-Ground Subway Section

Push-Rods Embedded in Tunnel Shell Concrete to Take Reaction of Shield Jacks — Shield-Driven Work Compared With Timbered Excavation—Evidence of Heavy Roof Pressure— Unusual Grouting Experiences

By W. C. Briggs
Engineer in Charge, Degnon Contracting Co., New York

In constructing a section of double-track concrete subway at 100 ft. depth in loose ground along Flatbush Ave., Brooklyn, two radically different tunneling methods were used: (1) Timbered excavation, and (2) roof-shield work, the roof shield traveling on the concrete sidewalls of the finished structure, built in drifts in advance of the shield. The former method was unusual in the arrangement of the several drifts and headings and the construction of the timbering, as well as in the sequence of concreting operations.



The roof-shield work was unique, because of the fact that the shield was shoved directly after the placing of a ring of concrete, the shield jacks depending for their reaction upon push-rods embedded in continuous lines in the concrete of the tunnel shell. So far as the author is aware, the combination of a shield, concrete forms and wet concrete immediately behind the shield had never before been used. The novel features of the two methods, as well as the fact that both methods proved themselves well suited to the work, warrant a brief description. An incidental point of great value is that a comparison of the working results throws some light on their relative advantages.

The work in question is a section of rapid transit subway 4,300 ft. long, extending under Flatbush Ave. from Prospect Park Plaza to a connection at Empire Boulevard with the reconstructed Brighton Beach line of the Brooklyn Rapid Transit Ry. Its construction, during 1916 to 1919, required about twice the time it would have taken but for delays resulting from war conditions.

Of a total length of 4,141 ft. tunneled (300 ft. at the south end of the section was built in cut-and-cover excavation), 2,293 ft. or 55.4 per cent was driven by timbered tunneling, while 1,848 ft. or 44.6 per cent, was driven by shield. The character of the material penetrated was variable. In general, the work passes through terminal moraine deposits, varying from clean, coarse sand, through clay (wet and dry), some of it containing fine sand, to hardpan which at times contained numerous and often very large boulders.

Timbered Tunnel

Four faces were operated by the timbering method, located as indicated in the plan in Fig. 1. The sequence of operations was the same in all four, with negligible variations in detail, and is represented in the composite sketch Fig. 2.

First a top center heading (1) was driven, by the poling-board method, with square-set timbering. The size and spacing of the caps varied with the ground conditions. At first 8 x 10 caps spaced 3 ft. 8 in. on centers were used; later they were changed to 10 x 12 spaced 3 ft. 10 in. on centers. Where the cover was about 30 ft. and the borings showed coarse sand from surface to subgrade, 12 x 12 caps spaced 4 ft. on centers were used. In all cases the caps were 15 ft. 4 in. long and the legs 9 ft., these dimensions defining the size of the heading. The poling boards were 2-in. hardwood (beech and maple).

Intermediate support of the caps was always necessary. As soon as a set was in place two plumb posts were erected under each cap, dividing it into three parts. After a number of sets had been placed, mud

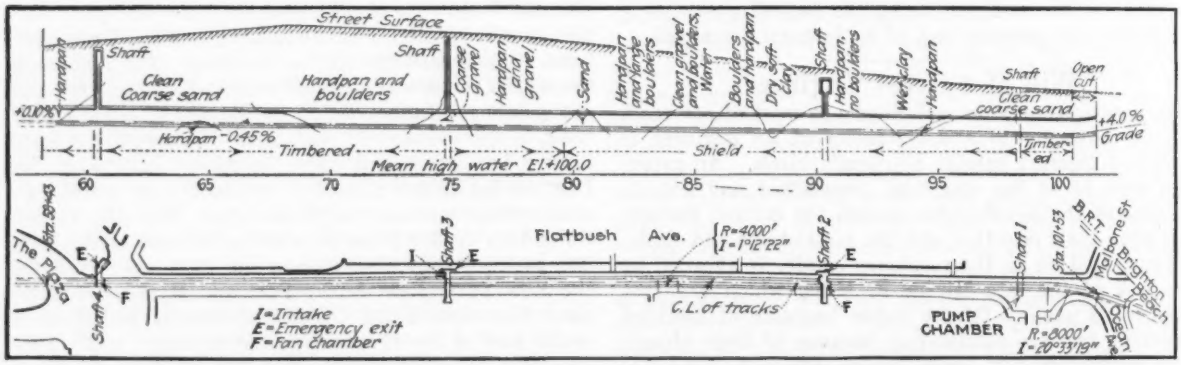


FIG. 1. DOUBLE-TRACK CONCRETE SUBWAY SECTION BUILT BY TUNNELING METHODS

sills and kneebrace frames as shown in the sketch were put in place, and the load was transferred from the two intermediate plumb posts to this frame. The frames were a very essential part of the timbering of the top heading, not only as support for the caps but also because it was important to have at least some of the roof load carried by continuous longitudinal sills as a protection against accident during the second operation. With the entire roof load supported on isolated posts, failure of the footing of a single post due to caving of the center-wall trench would entail the failure of the set, and this would inevitably be followed by the collapse of adjacent sets. The kneebraces also performed an important function in resisting the side pressure.

After the top heading had advanced two or three hundred feet, the second operation was begun. A

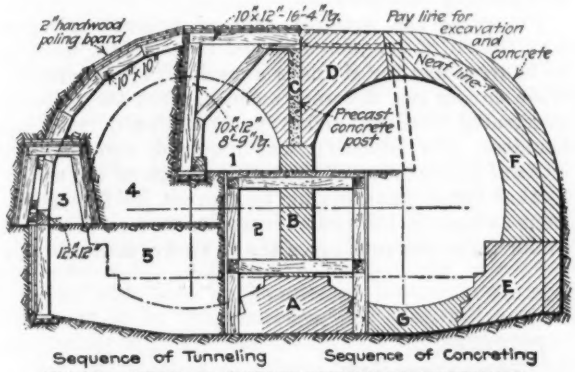


FIG. 2. SUBWAY CONSTRUCTION IN TIMBERED EXCAVATION

sheeted longitudinal trench (2) was excavated in the floor of the heading, down to subgrade, and in it was constructed the center wall of the subway structure, in two successive concreting operations, *A* and *B*. On this wall was erected under each cap timber of the heading a precast concrete post *C* which took the load carried by the timber kneebraces, permitting the removal of the latter. Thereupon the forms for the umbrella section *D* were pulled into place, and the umbrella was poured.

It is evident that when the work reached the stage just described, permanent support had been provided at the place where the greatest load would be developed in making the full excavation. To obtain this condition as soon as possible after the operations began was indeed the object aimed at in adopting this sequence of operations. As the work developed, it appeared to the author that it was the only safe way to prosecute the work by timbering methods for the reason that at isolated points there were failures of both caps and posts, through crushing and fracture, which showed that remarkably heavy loads were brought to bear on the sets. Calculating on the basis of the ultimate strength of the broken timbers, it was found that the load supported by the cap was equivalent to the weight of a column of earth extending all the way up to the surface, with base equal to length of cap times distance between caps (the load was not necessarily the weight of that particular prism, but the equivalent of such a prism.)

The failure of a cap or a post was always promptly detected and easily remedied. It was promptly detected because men were constantly passing through the top heading; and due to the size of the heading, their eyes were never far from the timber, inspection being therefore easy without special effort. After the first failure was noted, everybody connected with the work took an interest in watching the condition of the timber. Failures were easily remedied because all that was required was to introduce an extra set next to the one that had failed, the materials for which were ready to hand, as they were the same as those regularly in use. The loss due to the erection of extra sets was the only loss sustained on account of timber failures.

After pouring the umbrella concrete the wall-plate drifts were driven, on both sides; then, as soon as a wall plate had been placed, a set of segment timbers was placed in line with the cap, poling boards were driven, and area 4 was excavated. The wall plate was posted to subgrade in pits, in the usual manner, and the excavation (area 5) completed. The side-wall footings *E* were then concreted, after which the forms for the arches *F* were slid along into place on the completed side walls and poured. The concrete invert was placed at irregular intervals according to the situation relative to other work, usually on Sundays in order to eliminate interference with mucking.

In a number of cases the ends of caps crushed at *X*, where they cantilevered out of the umbrella concrete, after the segment timbers had been placed and the excavation completed. These failures are mentioned simply to indicate the intensity of loading which developed, as they caused no inconvenience. With this exception there never was an indication of unusual load on the timber after the umbrella was in place.

Roof-Shield Tunneling

Three miners, three timbermen and three helpers would make a set of top heading in a 9-hr. shift. In the wall-plate drifts one miner, one timberman and one helper would make a set, and in completing the arch (area 4) two miners, two timbermen and two helpers on each side made a set in a shift. This progress was made where the tunnel was in sand requiring careful timbering of the entire face of each drift. In hardpan and dry clay the progress was more rapid.

All of the operations could be conducted simultaneously and at times were; but it worked out better not to advance the top heading with the open trench. Note in the drawing that after the umbrella is in there is room for a small mine car to pass between it and the legs of the timber set.

The muck was loaded by hand into 1-yd. buckets on flat-cars running on a 24-in. track, which were hauled to the shafts by mules.

All concrete was machine-mixed, spouted down shafts into all-round dump cars, which were pushed by hand to the forms. These cars traveled on a track laid on a light trestle erected at about the spring line; the same track was used for the delivery of timber to the headings, thus separating the muck removal from the other operations.

The first step in the sequence of operations in connection with the shield-driven tunnel was the driving of three bottom drifts (Fig. 3), one on the center line and one at each side. The wall footings were concreted in these drifts. Inasmuch as the shield was

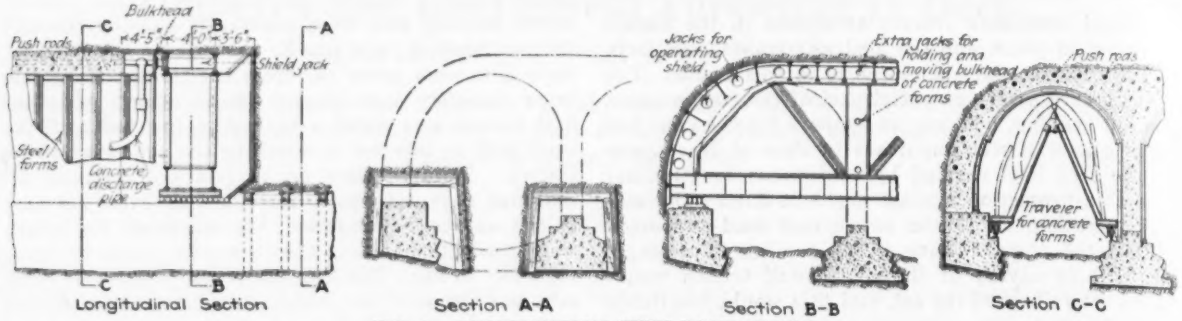


FIG. 3. CONSTRUCTION WITH ROOF SHIELD

supported entirely by the side walls, the center wall was built in advance of the shield only because it was impracticable to do this particular work as a part of the shield operation.

Shield and Push Rods—The shield measured 36 ft. 6 in. out to out in width and 11 ft. 11 in. in length. The cutting edge was 3 ft. 6 in. long, the body 4 ft., and the tail 4 ft. 5 in.. The skin was 1½ in. thick. The inside of the tail corresponded to the net outside of the heavier type of structure (for cover exceeding 60 ft).

Movement of the shield was effected by means of 14 hydraulic shield jacks with 7½-in. ram and 36-in. stroke, designed to net 32 in. for each shove. The rams reacted against "push rods," which were 4 in. extra heavy wrought-iron pipes 32 in. long filled with concrete, embedded in the concrete ring. The push rods were made up long in advance of their use; the concrete filling of the pipe projected 2 in. beyond one end of the pipe and extended to within 2 in. of the other end of the pipe, thus making what was in effect a bell-and-spigot joint.

A section of the bulkhead making up the concrete form between the arch forms and the inside skin of the shield was fixed to the end of each ram. After a shove of the shield had been completed, the rams were pulled in, carrying the bulkhead with them, and a push rod was fixed between each bulkhead and the end of the push rod on the same line already embedded in the arch ring.

At times considerable trouble was experienced with the rams due to ring and packing failures. While no better method for handling the bulkheads than that described in the foregoing paragraph seemed possible, nevertheless, in the opinion of the author, the packing trouble was due entirely to the bulkheads, the weight of which at the end of an extended ram caused relatively great and certainly unusual reactions on rings and packing of the rams.

Progress—The greatest rate of progress attained was 155 ft. of completed tunnel in a month, working 24 hours a day for six days a week. This record was made during two different months, when the material penetrated consisted of hardpan practically free from boulders. No breasting was required, and the face was cut out in front of the cutting edge of the shield, so that there was nothing to prevent its free movement as soon as the pressure was turned on the rams. Under these circumstances ten to twelve minutes only were required to complete the shove, and progress was limited only by the time required to move, line and fill the forms. When the face was entirely in sand and it was necessary to breast the face from top to bottom, the progress averaged about ten shoves per week. It is the opinion of the author that 155 ft. per month, or roughly two shoves a day, is the limit for equipment of this character, because at a higher rate the concrete behind the shield is not sufficiently set to prevent buckling of the push rods when taking the reaction of the rams.

The shield penetrated two peculiar formations. One consisted of gravel and boulders ranging in size from a few inches in diameter to upwards of 15 cu.yd., the interstices of which were entirely free from any fine material. It was a slow and difficult process to work the shield through this material, and the face had to be timbered over its entire area. To have attacked this formation by the timber method would certainly have involved great difficulties, if, indeed, it would have been possible at all. The other formation was

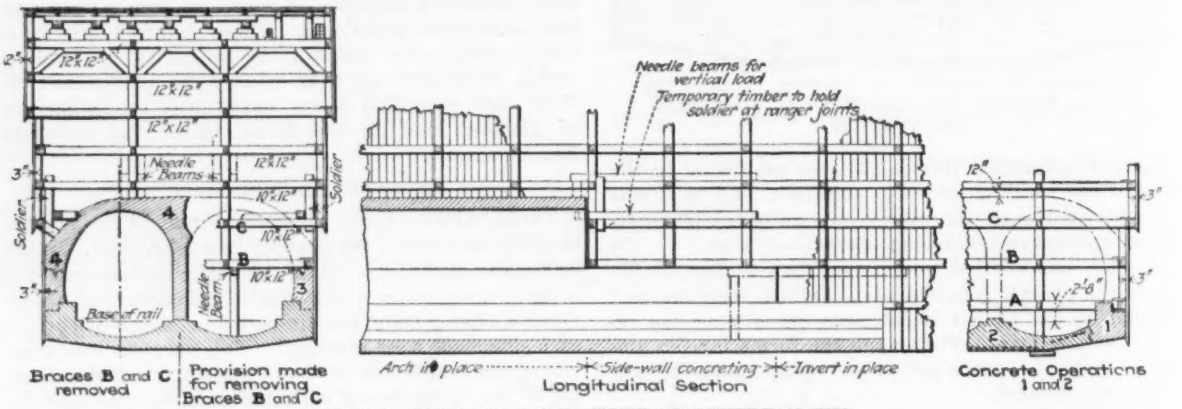


FIG. 4. DEEP OPEN-CUT WORK AT SOUTHERN END

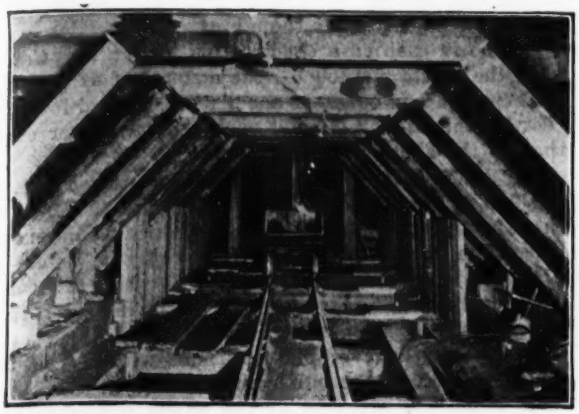


FIG. 5. TIMBERING METHOD: TOP HEADING AND CENTER-WALL TRENCH

the same as the one first mentioned with respect to gravel and boulders, but differed in that the interstices were completely filled with a matrix which bound the stone about as firmly together as if set in mortar. In this formation no timber was used, and frequently a boulder which had been exposed everywhere except on the back would stick in its place.

Blowing Concrete—All concrete for the shield-driven tunnel except that in the invert was placed pneumatically. Although some concrete was mixed as well as placed pneumatically, better results were obtained when the concrete was premixed and the pneumatic machine was used solely for placing.

For the purpose of conveying the concrete to the forms, the pneumatic machine was a success; indeed, it would have been well nigh impossible to have conveyed it to the forms under the circumstances by any other means. While it is generally true that the concrete was placed properly, it is also true that some difficulty was encountered on account of the segregation of ingredients, due to the confined space to be filled and to the fact that that space was obstructed by the push rods. In passing it may be stated here that the pneumatic machine was used very successfully for placing the concrete in a part of the tunnel built by the timber method. This particularly applies to the concrete poured into the umbrella, in that it was poured much more expeditiously and was packed up between the caps more completely.

Standard 6-in. wrought-iron pipe was used as a conduit for the concrete. The straight pipe withstood the abrasion for a long time, but bends of 6 and 8 ft. radius made up of extra heavy pipe often would fail after a few batches had passed through them. The straight pipe failed first at the joints, where the metal is thin due to the threads. Further, it wore out at the top rather than at the bottom, which would indicate, apparently, that the batch floated through the pipe. A very effective way of overcoming the short life of the bends was developed; it consisted of clamping a piece of scrap solid rubber tire to the back of the bend by means of a bent plate held by U-bolts drawn up to the limit, the result being that as the pipe wore out, rubber was forced into the hole and it absorbed the impact due to the stone. This scheme, together with reversal of the bends, resulted in a fairly long life for the bends.

In comparing the results obtained by means of the two methods, it must be borne in mind that whereas the shield was uniformly worked on a three-shift basis, the shifts being equal as to number and efficiency of the men, the timbered method on the other hand was never worked in three shifts, and during the comparatively short time that two shifts were used the day shift was always superior to the other in number and efficiency of the men employed.

It was necessary to operate the shield continuously because of the impossibility of determining the time when one element of the cycle of operations would end and another begin; and it was essential that an element should not be left in an uncompleted state. Therefore the shield organization was maintained at full strength at the cost of curtailing the strength of the other organization, where the cycle of operations was not fixed.

Under the conditions described, a progress of 100 ft. of completed tunnel in a month at a single face was

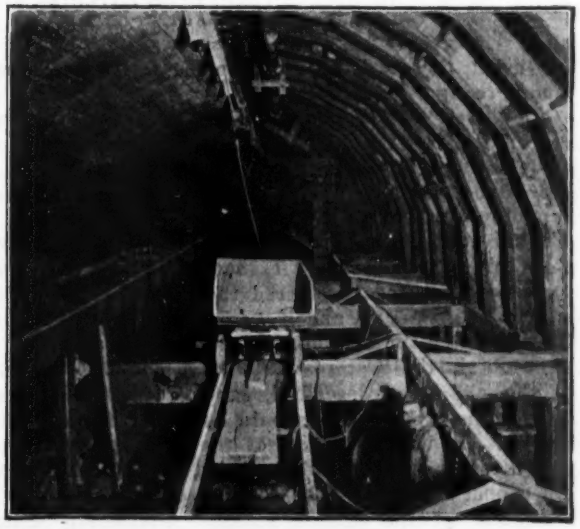


FIG. 6. TIMBERING METHOD: VIEW IN ONE TUBE, LOOKING BACK TOWARD COMPLETED TUNNEL
Umbrella at left; arch form in center background

attained by the timber method. From this it is a fair assumption that three equally well organized shifts would easily maintain the maximum rate attained by the shield, i.e. 155 ft. per month.

As to safety there is little to choose between the two methods so far as the actual results of the work disclosed. Both were safe. However, in the opinion of the author it was a very fortunate coincidence that the shield encountered the very wet clay and the boulder formations; for by the timber method this work would have been extremely difficult.

With regard to street surface settlement, conditions over the shield-driven tunnel were rather worse than those over the timbered tunnel, although, of course, there was more or less settlement over all of the tunnel. The settlement over the shield-driven tunnel resulted from two things: The void left by the skin of the shield, and the loss incident to the timbered tunneling in the drifts. The loss due to the drifts was not evident, generally, until the passage of the shield, probably because the surface over the drifts was supported through arching of the earth, which was destroyed by the opening made by the shield. In

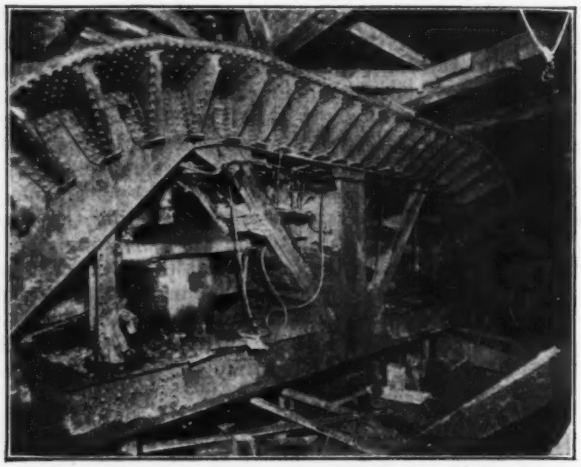


FIG. 7. SHIELD METHOD: CUTTING EDGE ENTERING AN INTERMEDIATE SHAFT

any event, there was a depression in the street all the time directly behind the shield.

An objection to the shield method as applied in this case is the fact that the failure of an element in the cycle of operations resulted in a delay to all. However, under normal conditions, with competent labor, this objection should not be serious.

While it is not important, it is interesting to know that foremen and men who had an opportunity to work both methods preferred the shield. The work seemed to go faster, and it was a satisfaction to see the completed tunnel close to the working face.

To obtain the best results with a timbered tunnel of the character described, in the opinion of the author, the top heading should be driven from shaft to shaft in advance of all of the other operations; for, after the top headings holed through, all the other operations could be conducted simultaneously, beginning at the shafts, without interfering with each other and under favorable conditions with respect to ventilation. The side poling-boards, legs, and sills of the top heading would all be used in timbering the final bore. The top headings were not run through in advance of the other operations on this job because of the uncertainty as to the extent that the timber method would be employed.

Comparative Costs—For *labor only* (includes mixing and placing concrete) the cost per lineal foot of completed tunnel by the timber method was 22 per cent greater than that by the shield method. The cost of the three bottom drifts is included in the shield-method costs.

Adding to the foregoing the cost of the power, the timber, the shield and the push rods, but not including the cost of concrete forms and ingredients, the cost by the timber method exceeded by 9 per cent that by the shield method. The wide difference between these percentages is accounted for by reason of the fact that the power charges against the shield method are much greater; that the push rods alone cost nearly as much as all of the timber for the timbered tunnel; and that the shield cost $12 per lineal foot of the shield-driven tunnel.

Relative to these comparative costs, it is important to note that the amount of both excavation and concrete was less with the shield-driven than it was with the timbered tunnel, although the pay section was the same in each case (See section in Fig. 1). Crediting the shield method for the amount of excavation not removed and concrete not placed but paid for, the cost by the timber method exceeded by 15 per cent that by the shield method.

The determination to use a shield on this contract was based on the assumption that by means of it a rate of progress could be developed which would make it possible to complete practically the whole tunnel—short sections at each end excepted—within the contract time limit. Due to war conditions, however, the delivery of the shield was considerably delayed; and the extremely unfavorable conditions with respect to the character of the earth encountered at the very start made the progress of the shield a disappointment, so that it became necessary to supplement it by adding the timber method. Had it not been for these contingencies, the author is of the opinion that, while the tunnel would not have been completed on time, using the shield alone, the delay would have been immaterial as compared with delays to subway work generally.

The statement in the foregoing paragraph has a bearing on comparative costs. As the shield was the major and timbering a minor consideration, the plant was all arranged to suit the former; and, by the time it was determined to push the timber method, adequate and suitable plant and labor were not readily available, due again to war conditions.

Grouting—The completed tunnel was grouted for its entire length. Grout-pipe nipples were inserted in the concrete ring at several points in a cross-section, in sections about 20 ft. apart. Experience disclosed that the best results were obtained by connecting to a nipple at the crown only, forcing the grout through that connection to refusal at about 60 lb. pressure. As grout appeared at open nipples adjacent to the grout connection, they were plugged and the process repeated until the connection refused. The grout machine was then moved forward to the nipple where grout last appeared and this treated to refusal.

Wherever a connection was grouted to refusal, a bone-dry tunnel resulted even where it had been quite wet before. At the point where the shield passed through the clean gravel formation the tunnel was very wet; and, while the grout cut off the water to some extent, it did not cut it all off. A very large amount of grout was placed in a short length of tunnel, but it was impossible to grout a hole to refusal. After having worked for some time at this point, with very little success, grouting was cut out for about ten days, new holes were drilled through the ring, and another attempt was made to cut off the leaks. However, this attempt also was unsuccessful. Evidently the grout just ran away.

Surface Cracks—An interesting development in connection with both tunneling methods was the occurrence of a series of longitudinal cracks which appeared in a gravel walk, closely following the progress of the headings. It apeared at a point horizontally distant from the bottom of the heading equal to one half the depth from the surface to the bottom of the heading. Where a crack appeared during the progress of the top heading, another appeared later farther away from the tunnel, but at the same rela-

tive point, when the excavation for the full section was completed. There was no variation in the location of the crack on account of the difference in the character of the earth penetrated.

In this connection a quotation from the minutes of the Institute of Civil Engineers, Vol. LXV, page 140, is interesting. "The slope of these fissures was so uniformly at the angle of ½ to 1, measuring from the bottom of the excavation, that the resident engineer professed to be able to foretell with certainty where a building or fence wall, standing over the tunnel, would crack." This is from a paper by Sir Benjamin Baker, referring to the London railway tunnels.

The contract was executed under the direction of John H. Delaney, Transit Construction Commissioner, succeeding the Public Service Commission, D. L. Turner, chief engineer, and Robert Ridgway, engineer of subway construction. The Degnon Contracting Co. was the contractor, H. C. Sanford, chief engineer, Francis Donaldson, engineer in charge from the inception to July 1, 1917, and the author from then until completion, John H. C. Gregg, principal assistant engineer, E. A. Herrick and John O'Keefe superintendents.

Strength Tests on Pre-Mixed Concrete on Detroit Street Railways

By W. R. Dunham, Jr.
Chief Engineer, Engel & Hevenor, Detroit, Mich.

Concrete mixed overwet at central mixing plant was used for the base of the new track construction of the Detroit Municipal Railway Lines, as described in *Engineering News-Record*, Sept. 29, 1921, p. 532. Strength tests, not noted in that article, were made during the work and show remarkably consistent and high results.

The type of construction adopted depends for its permanency on the concrete foundation. In order that the work could be carried on with the requisite speed to insure its completion in the time assigned, it was necessary that the concrete be mixed with an excess of water, and this was also thought to be desirable in order that the mixture would flow around the steel ties, thus thoroughly embedding the ties and rail bases in a monolith of concrete. Some tests made on the concrete are given here to show the compressive strength of concrete mixed to the consistency of pea soup. Exact percentages of water content are not available. There are included tests made from samples cut out of the work as actually laid, and from samples taken each day from the mixers. These latter samples were taken in 6-in. cardboard cylinders and tested at the ages as given. At the age of 40 days, blocks were cut from the concrete monolith at the locations where the concrete from which the samples were taken had been deposited. These were dressed to size and tested. Twelve sample blocks were made in the yards using the same aggregate, sand and cement, and kept moist, six of these were tested at the age of 81 days and six at the age of 91 days.

The aggregate used was Detroit River gravel known as forty-sixty, or 40 per cent sand and 60 per cent gravel. To make up the gravel deficiency, 25 per cent of ¾-in. to 2½-in. crushed furnace slag was added.

The aggregate was delivered to the mixers by gravity from two compartment bins, the aggregate in one compartment and the slag in the other. These were delivered by chute into the loading hopper and the cement was added, the concrete being a 1:2:4 mix. Water was added until the desired consistency was obtained, when the mixer was discharged into a train of hopper cars and the concrete was deposited. The average output per mixer per day was 400 cu.yd.

The consistency was such that the concrete flowed under and around the steel ties and up over the rail base, but to insure the avoidance of voids under the plates of the ties and under the rail bases the concrete was tamped. The plates on the ties had 1-in. holes drilled in them to allow the impounded air to escape and prevent the formation of pockets.

TABLE I. SUMMARY OF TESTS OF CONCRETE FOUNDATION

Test No.	Compression Strength, Lb. per Sq.In. 7-Day	28-Day
1	1,869	2,949
2	1,373	2,331
3	1,252	1,846
4	1,595	2,125
5	1,192	1,905
6	1,760	2,390
7	1,959	2,086
11	1,440	2,397
12	1,516	2,500
13	1,831	1,945
P-30	1,007	2,033
P-31	**675	**2,750
P-32	990	2,260
P-34	945	2,462
P-35	950	2,032
P-36	837	1,965
P-37	1,200	2,480
Average	1,317	2,262
Average first ten samples	1,579	2,247

** Least at seven days, next to highest at 28 days.

It will be noticed that the samples showing the least strength at seven days developed about the same strength at twenty-eight days as the other samples; and that the sample developing the least strength at seven days was the next to the highest at twenty-eight days.

TABLE II. POURED SPECIMENS COMPARED WITH THOSE CUT FROM STRUCTURE

		(Compression, Lb. per Sq.In.) 7-Day	28-Day	40-Day	
Molded in Cylinders	P-30	*1,007	*2,033	M-3,411	Cut from track slab
	P-31	*675	*2,750	M-2,388	
	P-32	*990	*2,260	M-2,785	
	P-34	*945	*2,462		
	P-35	*954	*2,032		
	P-36	*837	*1,965		
	P-37	*1,200	*2,480		
Average		944	2,283	2,861	

* Poured M Cut from slab

Samples cut from the base as laid at the locations from which the cylinders were filled give strengths as noted in Table II compared with samples taken from mixer.

TABLE III. TEST OF SAMPLES MADE AT YARD

81 Days	91 Days
2,972	2,454
2,609	2,644
2,328	2,450
2,229	1,923
2,083	2,179
1,322	1,968
Average 2,257	2,270

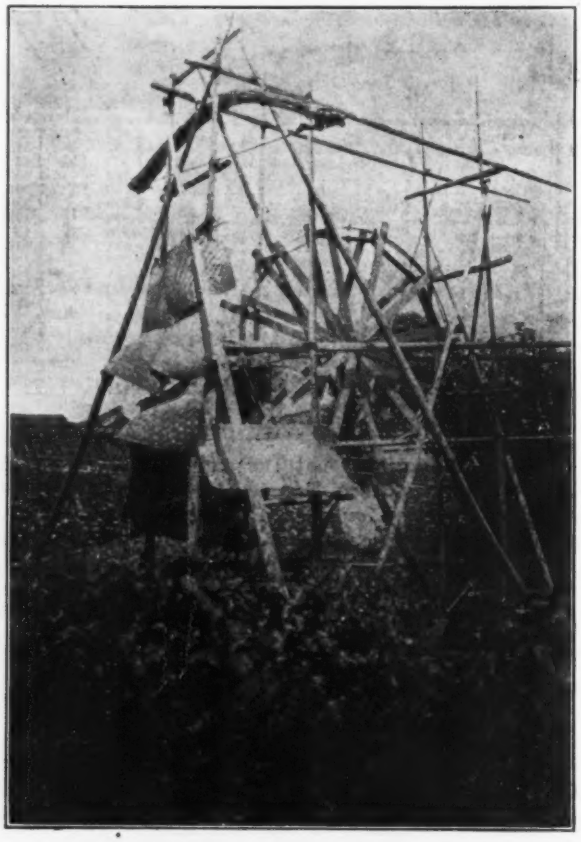
Tests of samples made at the yard using same proportion of aggregate and slag and same cement, and kept moist while curing are given in Table III.

An Oriental Well-Drilling Rig

By E. W. Lane
Manager, Morgan Engineering Companies in China, Yangchow, Ku, China

THE Orient is rapidly adopting the engineering methods of the West, with modifications to adapt them to the different conditions. Some of these modifications are very interesting and ingenious. One of the best which the writer has seen is the well-drilling rig shown in the picture, which is now used in Central China, but was probably developed by the Japanese.

The unique features of this device are the use of a



CHINESE WELL-DRILLING DEVICE

huge bow for balancing the weight of the drilling rod and cable, and the "squirrel cage" treadmill by which the baler is raised.

The bow is composed of a bundle of bamboo poles and is suspended at the top of a frame work of poles in such a manner that the center of the bow string is directly over the point where a well is desired. From the center of the bow string is suspended the drill rod which is churned up and down by man-power. The tension of the bow balances the weight of the rods and cable and at the same time, by its flexure, allows the churning of the drill rod. The drilling cable consists of strips of bamboo about 1¼ in. wide by ⅜ in. thick and 15 ft. long ingeniously fastened together by small iron rings and wedges. The bamboo cable does not connect directly to the bow string but the extra cable is wound on the reel, a rope from the center of the bow string being fastened to the cable just above the top of the well with an adjustable connection which allows the lengthening of the cable as the well deepens.

Raising the drill rods from the well, or baling out is accomplished by winding up the line on the reel shown, the power being supplied by men walking inside the reel in squirrel-cage or treadmill fashion.

At the time the above photograph was taken a well with a 3-in. pipe casing was being driven at a depth of 80 ft., although depths of 200 ft. are said to be common. The drill rod and baler were similar to those in common use in America.

Repair of Concrete Pavement With Gunite Unsuccessful

A PAVED street in Aberdeen, Wash., in which grooves were made by heavy traffic before the concrete was allowed to harden properly, according to the contractor's claims, were recently repaired with gunite. A 30-day period was allowed for hardening the gunite and then the street was again opened to traffic. After a short period of service the gunite began to peel off and soon its condition was no better than before the repair was attempted. Some of the conditions involved that might be useful in comparing this experience with similar work contemplated elsewhere are given in the following:

The original pavement was made with a 1:2:3 mix; is 8 in. thick and 10 ft. wide on the south side of a street-car track. The 30 days allowed for hardening was claimed to be insufficient on the ground that during the time of pouring and curing the daily temperatures approximated the freezing point and the nights were below freezing point.

When the pavement was thrown open to traffic, auto trucks, being obliged to travel in practically the same tracks, because of the operation of street-cars, soon wore off the surface in two longitudinal strips, 10 to 12 in. wide under each wheel track. These grooves ranged up to about 1 in. in depth. This wear developed within a week after the pavement was opened and then city officials closed the street and notified the contractor that the pavement was considered defective and his final payment would be withheld. Decision was then made to attempt making repairs with gunite.

The grooves in the old concrete were thoroughly cleaned out with wire brushes and the gunite was shot on in thicknesses ranging from a feather edge to 1 in. where the raveling was deepest. The gunite was cured in the same manner as the original concrete, being kept wet for the first ten days and then air-cured for twenty days more; this curing, however, being under favorable weather conditions. The repair work cost more than $1,500, it is stated, and it is said to be a complete failure. Since the pavement was opened to traffic for the second time six months ago, there has been no further raveling or breaking up of the original paved surface.

The 10-ft. strip on the north side of the street, built in the light of experience with the south half, was kept closed to traffic and allowed to cure for 90 days. After six months of traffic the north side of the street is said to be still in excellent condition, showing no signs of wear whatever.

Underground Water Storage on The Santa Ana Cone

Flood Spreading Since 1911 on Southern California Stream Proves Success As Conservation Measure

By Hyde Forbes
San Francisco, Cal.

IN SEMI-ARID SECTIONS where stream flow is torrential in character, nature provides better and far more extensive reservoirs, in the form of debris filled valleys, than could possibly be obtained by developing artificial reservoirs in the mountains. The utilization of these natural reservoirs has become a large factor in the development of semi-arid regions and western engineers are more and more frequently being faced with problems as to their extent, duration of the supply and the sources of their replenishment. In the following some notes are given on underground storage in Southern California in general, and in particular on the results of studies made on the debris cone of the Santa Ana River.

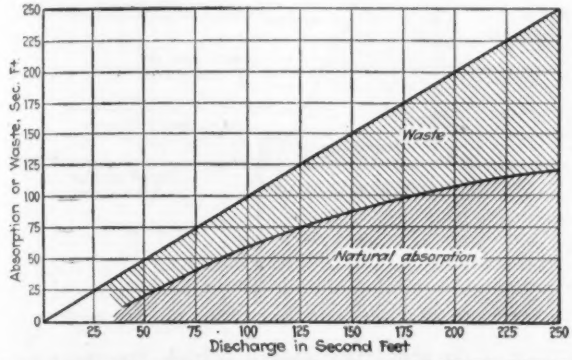


FIG. 1. RELATION OF NATURAL ABSORPTION TO TOTAL FLOW, SANTA ANA RIVER

Subterranean Storage Conditions—Southern California depends to a large extent upon underground sources for its water supply and there has been marked development of these in recent years. Not only are underground storage basins becoming a source of water for domestic and municipal water supplies, but large areas are being irrigated with water pumped from underground reservoirs onto arid bench lands and valleys.

Alluvial valleys or debris cones are built up by a ramification of lenzes of stream-deposited material which varies from fine clay to coarse gravel and boulders. The void spaces in these deposits act as a storage reservoir for percolating water. The greater the volume of void spaces that may be filled with water, the more extensive the reservoir will become. Moreover, the frictional resistance of the material is such as to retard the movement of the water, thereby materially affecting the time over which it is available.

Water Diverted on Santa Ana Cone—The Tri-counties Conservation Association has accomplished a material increase of capacity of one of these natural reservoirs on the Santa Ana debris cone in San Bernardino County, Cal. In general the method used is that of diverting the winter flow from the river channel into numerous streams and also impounding portions in ponds, thereby increasing the wetted area

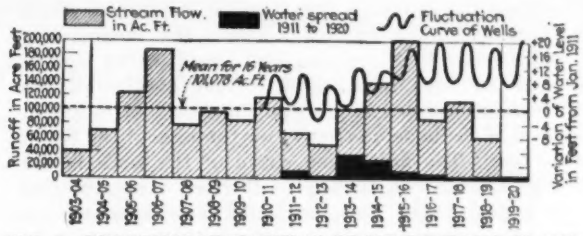


FIG. 2. RELATION OF NATURAL FLOW, DIVERSIONS AND UNDERGROUND WATER LEVELS

Note how effectively methods applied on the Santa Ana cone utilized underground storage during dry years.

and decreasing the velocity. Although this work was undertaken as early as 1911, it is only recently, after a considerable period of time and a series of dry years, that it might be determined just what effect the artificial spreading had on the supply and whether that spreading resulted in actual conservation of water for use during periods of low replenishment.

During the early spring months of 1915 the writer made a detailed study of the effect of this spreading. The work consisted mainly in measurements of stream flow from which was determined the relation between the total flow of the surface stream below a stage of 250 sec.-ft. and the natural seepage loss throughout the entire length of the river channel across the debris cone. This relation is shown in Fig. 1. From these data it was possible to determine the percolation loss which would have taken place naturally had not the diversions been made, and to compute, from the diversion records, the amount of water actually added, (net conservation) to the storage reservoir during the period considered. The actual figures are as follows:

TOTAL FLOW OVER CONSERVATION WEIRS, SEASON OF 1915, IN ACRE-FEET

	Jan.	Feb.	Mar.	April	May	Total
Upper Weir	788.91	1,370.14	2,117.66	2,555.80	2,469.71	.....
Middle Weir	317.17	2,115.86	2,871.38	1,304.81	3,034.0	.....
Lower Weir	433.60	1,459.14	2,386.14	642.60	3,049.5	.....
Total	1,539.68	4,945.14	7,975.18	4,303.21	8,555.21	27,316.4

The net conservation for the year 1915 therefore, based on the ratio determined for March, April and May, was approximately 13,000 acre-feet. Upon the same basis, about 20,000 acre-feet of water were conserved in 1914. The year 1916 was one of high runoff with several flood periods. It was impossible during that year to control the stream and diversions were not as extensive as the two preceding years. However, the natural seepage losses were much greater than those that had occurred for several years prior to 1916.

In conjunction with the river measurements, the writer selected a number of wells covering the affected area and made continuous water level measurements. A test pit in the midst of the spreading area registered a rise of over 50 ft. during that part of the spreading season from Feb. 20 to May 31 and fluctuated with the commencement and cessation of spreading operations. Similar rises were measured throughout the Santa Ana Cone but varying in extent according to location. These well measurements have been continued until the present time.

Results of the Studies—The interesting feature of this work is its affect during a series of dry years.

This is readily shown in Fig. 2 which indicates through the year 1920, the relation between the stream flow of the Santa Ana River plus Mill Creek at the mouths of their canyons, together with that portion of the winter flow diverted and spread, and the variation in the level of the underground water throughout the Santa Ana Cone. The fluctuation curve of the wells is the average seasonal fluctuation of thirteen representative wells covering the area, with the low point of the seasonal fluctuation at the end of 1910 assumed to be zero in each well. The average accumulative rise over the six-year period, to the end of 1916, was ± 8 ft.

Increased Storage Capacity

The average normal grade of the water-table prior to 1911 beneath the Santa Ana debris cone was about 20 ft. to the mile. After the spreading operations had been carried on, the grade increased to an average of 50 ft. to the mile in 1915. As the water-table rises and falls during the season with a fixed point of slight seasonal variation in the artesian area (due to escape of ground-water through surface drainage in the Santa Ana River channel and Warm Creek together with escape from artesian wells during the irrigation season) and a seasonal variation of about 75 ft. measured in the center of the spreading area, the additional area of void spaces filled with water probably averages about 75 ft. high. Furthermore, the building up of the water-table from the stream channel under natural conditions would be somewhat limited to that area beneath and adjacent to the stream channel. The conservation ditches carry the water over a greater area, thus building up a water-table of nearly uniform height across the entire debris cone. In this manner considerable additional storage capacity was made available.

After the water-table had been built up to the 1915 level it has been maintained with the lesser amounts of water spread since 1915 through a series of four dry years. This is effected through the frictional resistance offered by the impounding material against the movement of the underground water. Pressures are released when the deeper artesian wells are uncapped and pumping operations are commenced in the shallower wells in March or April. The result is a lowering of the water-table, greater in extent at the apex of the cone. In the fall of the year the artesian wells are capped, pumping operations are discontinued and the water-table is again built up through natural seepage and consedvation processes.

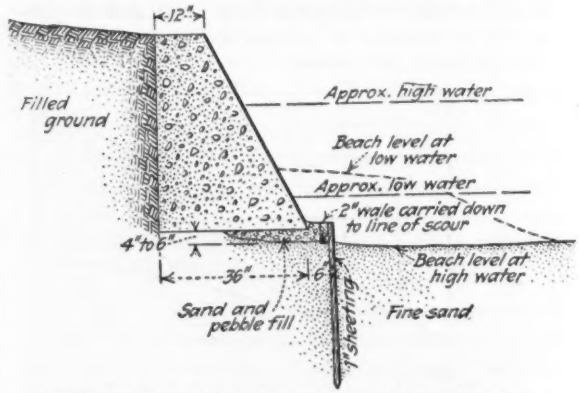
During the past few dry years the extractions from the basin for irrigation purposes exceeded those of years of normal or excessive rainfall yet the water table showed no marked lowering. In other words, the work of the Tri-Counties Conservation Association has shown that water may be stored during periods when it is not needed, for extraction during periods when it is extremely valuable. What has been done on the Santa Ana Cone can be duplicated on many such cones throughout California, in the writer's opinion, and no alarm need be felt by users of underground water because of the lowering of the water-table during the recent series of dry years. The extracted waters can be readily replaced and supplemented with additional supplies by use of proper methods of spreading of the unused winter flow.

Preventing the Undermining of a Small Sea Wall

By Leo G. Hall
Onekama, Michigan

THERE are on the rivers and lakes of this country a great many small masonry or concrete walls built to protect the banks from erosion. It frequently happens that shifting sands and currents threaten to undermine these walls. Two common methods of protecting such walls from undermining are piling brush or boulders on the bed in front of the wall. A third cheap and effective method which the writer has used and is using to protect a wall along the waterfront of his home on a lake in the sand country of Northern Michigan, where rock is scarce, is illustrated in the accompanying drawing.

The lake waters vary about 3 ft. in height through a cycle of about seven years. When the water is low, the waves beating against the shore build up the beach



SECTION OF WALL AND SHEETING PROTECTION

in front of the wall. But when it is high, the undertow from the waves scours out this beach, and tends to undermine the wall.

By driving a row of sheet piling in front of the wall, the sand is prevented from washing out from underneath it. Even though of light construction the sheet piling, when driven about to the level of the base of the wall, is not liable to be damaged by the ice. The sand which it holds in place, in turn protects it. It is far enough from the toe of the wall so that the line of pressures from the weight of the wall does not act against it, even when the sand outside the sheeting is scoured to its full depth. Also the 2-in. wale which serves as a guide in driving and which is of sufficient depth to reach the line of scour, prevents the fine sand from filtering through the sheeting. The small space inside the piling and under the wall is then filled with sand and pebbles.

During low water the whole construction is covered under a foot or more of sand, and cannot be damaged. The writer was of course helped in this case by an exact knowledge of the depth of scour as observed over a period of many years. In most cases heavier sheeting would be required. But after all, the greatest skill in engineering lies in doing things as economically as possible, and in this case and others, 1-in. sheeting has been found sufficiently heavy.

The cost of this protection runs about 18 cents per lineal foot.

Accounting Records for Consulting Engineers

Arguments for Keeping Books with Segregated Costs—Details of a Loose-Leaf System—Forms for Expense Vouchers and Time Distribution

By Arthur L. Mullergren
Benham & Mullergren, Consulting Engineers, Kansas City, Mo.

FEW consulting and practicing engineers attempt to keep a set of books and accounting records of their operations. The profits and losses derived from their business are usually determined by the bank balance at the end of the year. It makes little difference whether the expenditures were made for furniture, fixtures, tools, instruments, supplies, personal items, development of business or actual operation—all are treated alike. This lack of system may be due largely to the assumption on their part that the practice of engineering is similar to the practice of medicine or law and that cost accounting and records of operation are neither necessary nor desirable. Another argument advanced against such a so-called "refinement" is that the fees are fixed by precedent and the national societies, and therefore, records of the cost of operation are unimportant and useless.

As a matter of fact, if the engineers knew the exact cost of performing certain services it is very probable that more concerted action might be obtained toward the securing of adequate and proper fees. Generally speaking, present-day fees and charges were established years ago when the services rendered for these fees were limited. It should be borne in mind that with the advancement of the science present-day practice calls for greater skill and specialization, thus making for higher costs of rendering the proper service. The engineer of today cannot conduct his business in the same manner as the engineer of years ago. Today the engineer having a practice of any consequence must maintain an organization of specialists while a few years ago a few draftsmen constituted the organization.

Engineering is a business as well as a profession and engineers should recognize this fact. Today there is keen competition among the engineers and business methods must be employed. This does not mean that the standing of the profession is likely to be or is being lowered, as proper business methods can be successfully employed that are in keeping with the dignity of the profession. Although the average engineer understands very little of accounting practices and methods, it is very important for consulting and practicing engineers to have a general knowledge of accounting. They are called upon frequently to determine the feasibility of a great many proposed projects from an economic standpoint. The economic feasibility is largely determined from the yearly fixed charges and operating costs and this necessarily calls for an understanding of accounting principles and methods. In appraisal and evaluation work accounting and engineering go hand in hand. In rate cases and in preparing reports on utilities and industrial properties a knowledge of accounting is very essential.

This general lack of knowledge of accounting is probably one of the principal reasons why the engineer has not taken the trouble to maintain a system of accounts for his own business. Proper records and accounting methods are very essential to any undertaking or business. These are necessary to an engineering business conducted by a partnership or a corporation for determining the true net profits of the business, for apportioning the assets and liabilities in the case of a dissolution or the withdrawal of a member and in determining the costs of service. The individual engineer needs a system for determining his true profits and the costs of performing the different classes of service.

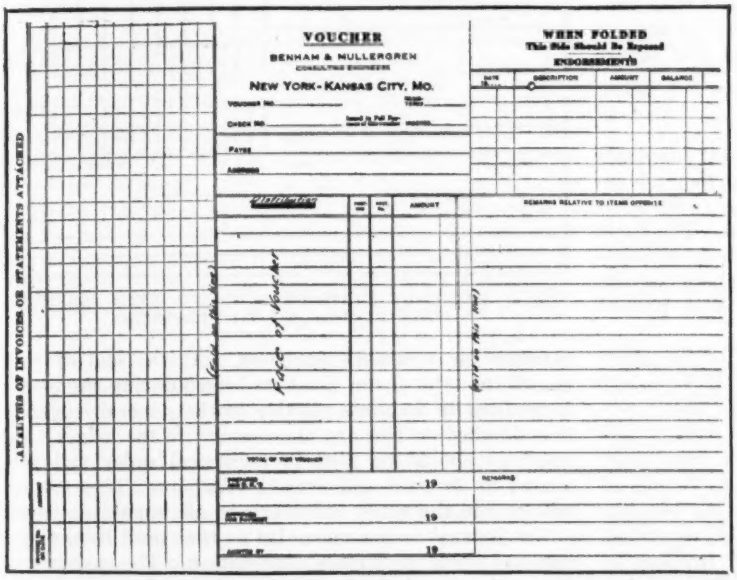


FIG. 1. VOUCHER FORM FOR ACCURATE EXPENSE DISTRIBUTION AND HISTORY OF TRANSACTION

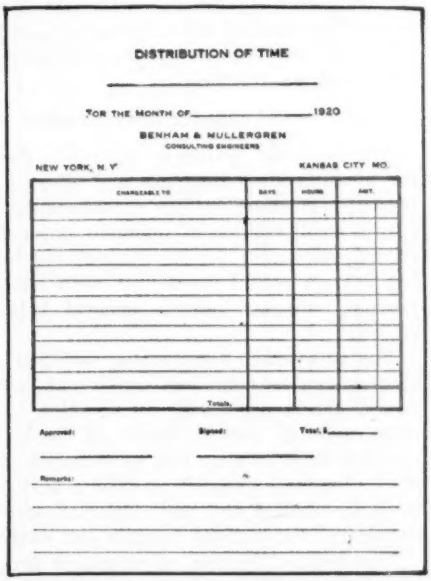


FIG. 2. DISTRIBUTION OF TIME TURNED IN ONCE A MONTH

The proper system to be used and the degree of refinement to which it is to be carried out depends largely on the kind and size of organization, and volume and class of work handled. The larger the organization or volume of business the more elaborate should be the detail of accounts. The object is to provide a workable system neither burdensome nor expensive to maintain, but one that is in keeping with the business in hand and so established that it can be expanded as the organization and business grow. The fundamental system should, therefore, be established with care. A certified or public accountant should be consulted at the very start. He should be fully advised as to the character and extent of the business conducted at the time and the prospects for increase, with the possible extent of same and the ultimate scope of the business. This information will enable the accountant to open a system to fit present needs and one that can be expanded as the business warrants. It should be borne in mind that the scope of the engineer's activities broadens with time and the increase of the organization, so that the present activities are not altogether indicative of the future scope and possibilities.

Loose Leaf System

The loose-leaf system of records is the most adaptable for an expanding business and offers a further advantage of combining various records under one cover when only a small volume of business is handled. The basic records necessary for an engineering business accounting system would consist of cash book, check record, journal, voucher record, general ledger and project record.

For an average engineering business all of the above records can be combined under one cover if loose-leaf record sheets are used. In addition to the above records, monthly record sheets of bank statements and monthly trial balance can be included in the one cover. If the business expands so that a very large volume of work is handled and more detailed accounting becomes necessary, the various records can easily be separated.

Vouchers.—The use of vouchers for all invoices or accounts payable is highly recommended. The voucher system enables the making and keeping of an accurate distribution of all expenses and keeps a permanent record of the transaction as well as the original invoice. For the average engineer or engineering organization the voucher check or voucher receipt is not recommended. The voucher should be an office record and the notation on the voucher of the check number by which the account was paid gives sufficient evidence of payment of the invoice without having the payee's signature on the voucher proper. Furthermore, the invoice marked "paid" can be attached to the voucher. The voucher recommended should be made of thin, tough cardboard so as to be folded easily and not be too bulky when the invoices are attached.

Fig. 1 shows the form of a voucher that will fulfill the requirements of the average engineer as well as a very large organization. This voucher folded measures 4¼ x 9 in. The original invoices are attached to the voucher. The distribution of the charges, the payee, voucher number, number of check by which paid and total amount of voucher are listed on the face, so that full information of the transaction is readily obtainable. In the event any partial payments are made on account from time to time or credits given, a space is provided for indicating them, as shown in the column marked "endorsements." This column provides space for listing the check number of item of credit and a balance column to show the unpaid balance of the voucher. Further space on the voucher is provided for making detailed analyses of the charges to the various accounts. The vouchers are registered by payee's name, voucher number and amount in the voucher record in numerical order and each month's entries are separated. The vouchers are numbered consecutively for an entire year or longer, as desired. The vouchers are also indexed alphabetically by means of a small card index system. A separate card is used for each payee and the same card can be used for a number of vouchers having the same payee. On the card are listed the voucher number and the month issued. This enables the ready location of the

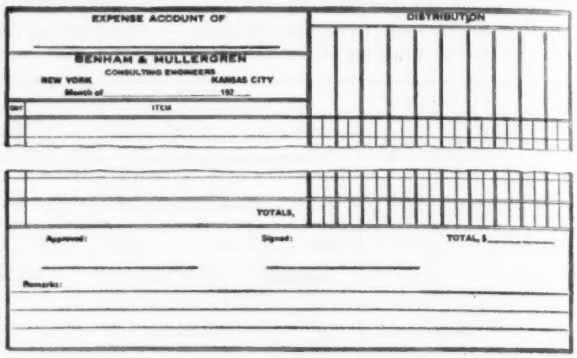


FIG. 3. MONTHLY EXPENSE ACCOUNT WITH DISTRIBUTION ACCORDING TO PROJECTS

voucher for reference purposes. At the end of each month the total of the vouchers issued during the month is credited to accounts payable in the general ledger so that detailed entries are unnecessary in the ledger. All vouchers should be filed in numerical order and separated as to paid and unpaid vouchers. This method will enable the ready reference to all unpaid accounts.

The journal is the same size as that used in any system and needs no further explanation. The cash record is merely a cash book showing the cash received, the date, whether the money was paid on accounts receivable or was a cash transaction, and daily charges to the bank. The check record is used to record all checks issued. Columns should be provided for date, check number, payee, account number to which charged, accounts payable and miscellaneous. The total of the charges to accounts payable at the end of each month is taken from the accounts payable column and charged to accounts payable in the general ledger. The general ledger accounts should be opened to suit the business in hand. For the average engineering business the asset accounts would consist of (1) accounts receivable, (2) notes receivable, (3) bank statement, (4) petty cash, (5) furniture and fixtures, (6) tools and instruments, (7) library and (8) investments. The liabilities accounts would consist of (9) accounts payable, (10) accounts payable employees and (11) notes payable. The remaining accounts would be (12) capital stock or present worth, (13) surplus, (14) income and (15) expenses.

The income should be divided into two accounts, fees and miscellaneous. The fees account would represent all income received from clients for professional services. The miscellaneous account is used to handle the

income received from deposits on plans and specifications, sales of supplies and any other income derived from other than professional service.

The proper division of the expenses will depend largely on the class and volume of business handled, but the following classification of expense accounts will probably serve for a general engineering practice: (1) project expenses; (2) general expense; (3) office expense; (4) printing, stationery, supplies and postage; (5) office rent; (6) telephone and telegraph; (7) taxes and insurance; (8) legal expenses; (9) organization dues and periodicals; (10) interest paid; (11) development and advertising; (12) general salaries.

Project Expenses

Project expenses would include all expenses directly chargeable to the various projects such as resident engineers' salaries, traveling and hotel expenses going to and from the project, blue printing, supplies and the time of office principals and assistants actually engaged on the particular work. The project expense would, therefore, represent the total direct charges to all of the projects handled during the period. The charges to each project are kept separately, as will be shown later. The other detailed accounts are more or less self-explanatory and represent general costs not chargeable to any one particular project and are termed overhead expenses. The development and advertising accounts represent expenses incurred in attempting to secure new work and for professional cards and other advertising. It frequently happens that several months may elapse between the time of the first expenditure made in attempting to secure an engineering contract and the date of its signing. The expenses incurred from time to time should be charged to this development account until the project is secured. Then all such charges to this particular project should be transferred to project expense, thus making each project show its actual total cost. Therefore, when the books are closed, the development and advertising accounts represent expenses incurred only for advertising purposes and unsecured contracts. This account corresponds to the average mercantile concern's advertising and new business expense.

Project Record—All accounts should be given a number for the purpose of making proper reference entries. There should also be included in the records a distribution sheet for each project. This enables the posting of charges to each project directly from the voucher at the end of each month. The sum of the monthly entries to the various projects is then entered in the expense sheet headed "project expense." This distribution sheet for each project shows the total direct expenditures made for each particular project, so that the total cost of the job at any time is easily ascertained.

Cost Distribution

There should also be kept an additional record of the projects in a separate loose-leaf book. This project record will show the total charges to the particular project at the end of each month as taken from the distribution sheets in the large record and carried forward accumulatively. The overhead expenses as designated above are apportioned to the various active projects in accordance with their size and importance and charged to the respective projects in this project record. Credits to each project are also to be shown in this record, consisting of the payments made by the client. The balance column will indicate the profit or loss on the particular project at any time.

In addition to the above set of records, there should be a small loose-leaf accounts receivable ledger listing each client separately, which would represent the total contract fee, the payments made from time to time and the balance due. The total of the balances in this accounts receivable ledger should correspond to the amounts shown in the accounts receivable sheet of the general ledger.

Time Segregation—In order accurately to make the proper charges to the various projects and to keep an accurate record of the various expenses, it is necessary that the principals as well as assistants keep a daily record of their time and any expenditures made for the operation of the business. The time of everyone connected with the organization should be made out so as to show the time devoted to each particular project, general office matters, new business, etc. The form similar to Fig. 2 has been found satisfactory for this purpose. This sheet is turned in to the bookkeeper at the end of every month. It gives complete information of the time and amount chargeable to each project or other account. An expense account sheet similar to Fig. 3 should also be turned in monthly by everyone making any expenditures for the business and the expenses should be detailed and separated as to the various projects or other accounts. Both the expense account and distribution of time sheets for each individual are attached to one voucher and the charges to the various projects or accounts summarized and listed on the face of the voucher.

The above is a general outline of a system of records that has been in use by our office for a number of years and has been found entirely satisfactory. As previously mentioned, it is recommended that a competent certified accountant be consulted for the establishment of any set of records or accounts, as no one particular system would apply to all classes of business. It will be found that a proper system of accounts becomes indispensable after using one for several months, and the desire of this paper is to set forth the advantages of a proper system of accounts and records for consulting and practicing engineers.

British Railways Combined in Four Groups Is Government Proposal

Consolidation of the entire railway system of England and Scotland into four large groups instead of six as originally proposed (see *Engineering News-Record*, Feb. 24, p. 341) is provided by the government bill now before Parliament. These groups, all radiating from London, are to be approximately as follows: (1) Eastern group, 6,670 miles, north of London and east of a line drawn a little west of north; (2) Midland and Northwestern group, 6,680 miles, between the above line and another drawn northwest from London to Liverpool; (3) Great Western group, 3,420 miles, between this last line and a line drawn southwest from London to Plymouth; (4) Southern group, 2,130 miles, south of the Thames and of a line drawn eastward from London. All the groups interlock and overlap more or less. The mileages given, totaling 18,900 miles, are those of the several large companies only and do not include the numerous small lines which will be absorbed into the groups.

Large Roofs Suspended by Cables To Avoid Columns

French Engineers Have Applied This Novel Design to Airship Sheds, Giving Unobstructed Full Length Side Openings

SUSPENDED roofs for structures in which it is desirable to reduce the number of supporting columns to a minimum is an important innovation in structural engineering which was developed in France during the World War and has been applied to a number of structures. This type of construction is adapted for large shop buildings, for airplane and hydroplane sheds or hangars, and especially for the very large sheds required to house modern dirigible airships. The suspension system consists of a pair of trusses in which the chords

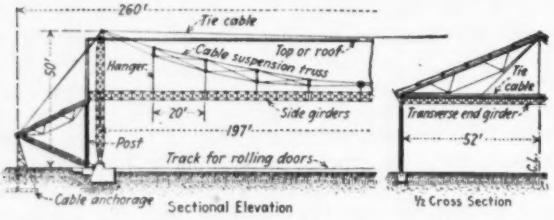


FIG. 1. SUSPENDED ROOF FOR HYDROPLANE SHED AT CHERBOURG, FRANCE

are wire cables, separated by vertical struts and having diagonal members in the panel thus formed. Hangers at panel points are attached to the longitudinal girders of the roof framing, the trusses being placed over the side of the roof. The use of suspension cables to carry the trusses of long-span signal bridges on the French State Railways was noted in *Engineering News* of Aug. 12, 1915, p. 293.

This novel method of roof support is described in *Le Genie Civil*, of Paris, from which the following information has been taken.

In the first place, the suspension system is not entirely new. It was proposed in 1833 for a shop at the

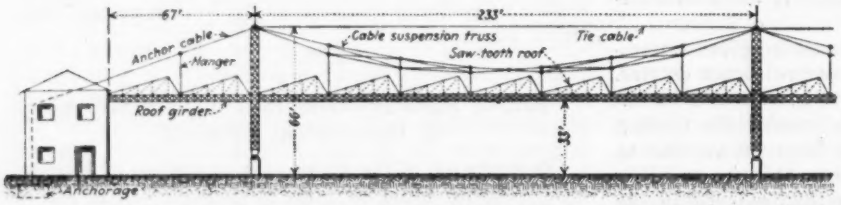


FIG. 2. LONG SUSPENDED ROOF OF SHED AND REPAIR SHOP FOR AIRSHIPS AT BIZERTA, TUNIS

arsenal of Lorient, Frence, by Mr. Laurent, an engineer of the French navy department. This roof, built in 1837 and said to be still in existence, has a length of 143 ft. between supports, with a width of 71 ft. and a headroom of 8 ft. Parabolic suspension trusses were built of eyebars. As the roof is low and heavy and situated in the interior part of the arsenal, it was not subject to serious unsymmetrical loads, for which trusses of this kind are not well adapted. It is now recognized, however, that snow and wind loads are not applied uniformly over large roof areas and that provision must be made for upward wind pressures, especially in structures near the coast. It is recommended that the roofing should weigh not less than 8

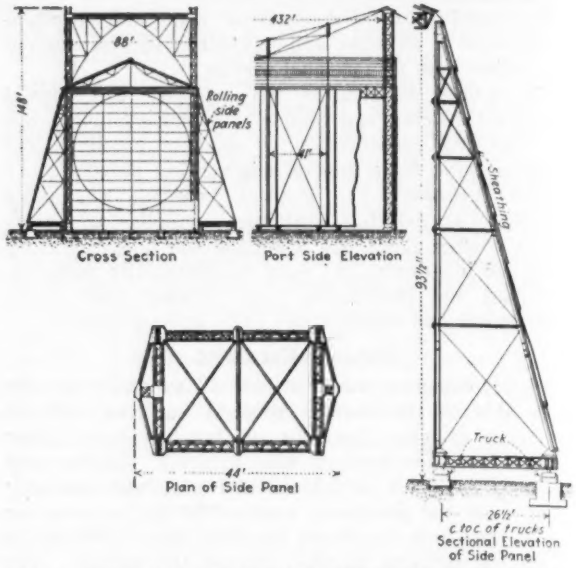


FIG. 3. SHED FOR DIRIGIBLES, WITH SUSPENDED ROOF AND ROLLING SIDE PANELS

lb. per square foot and should be well secured to the purlins.

Anchorages of a novel type are employed for the suspension trusses of a hydroplane shed at Cherbourg, Fig. 1, owing to the small amount of space available. This shed, which was being erected at Havre at the time of the armistice, has four tall end columns carrying trusses of 197 ft. span. The columns are mounted on pin bearings, and to resist the pull of the cables they are guyed to inclined anchor booms seated against the masonry pedestals of the towers, as shown. In this way the total length of anchorages for a 197-ft. span is only 260 ft. Transversely the towers are spaced 105 ft. c. to c. Two cables are used for each chord of the suspension truss. Rolling doors or panels 16½ x 26½ ft. can be run one behind the other so as to give an opening 100 ft. long at any part of the side of the building. Two other sheds of this type, but with roofs 394 x 210 ft., have been built at the Cherbourg arsenal.

A combined hangar and repair shed having three suspended roof spans of 233 ft. and a total length of 833 ft. (including end sections suspended from the anchor cables) was under construction at the Bizerta arsenal, in Tunis, at the time of the armistice. In this large shed, Fig. 2, the roof was 132 ft. wide and 33 ft. above the ground. Upon its longitudinal girders was carried a saw-tooth roof covering, and the framing included girders designed to carry traveling trolleys for hoisting and handling heavy loads.

To facilitate the delicate operation of getting large dirigible airships into and out of their sheds during high winds, Captain Cazenave and Inspector-General Minard, of the French aeronautical service, in 1917 undertook to design a shed in which the rolling side doors could give an opening the full length of the shed and could also be used as a protection or wind shield in any direction. This shed, which also was

under construction at the time of the armistice, is shown in Fig. 3. It has a roof 432 x 82 ft. and 92 ft. above the ground, suspended from cable trusses attached to end bents 148 ft. high. The sides consist of panels 93½ ft. high and 36 ft. long, with triangular frames

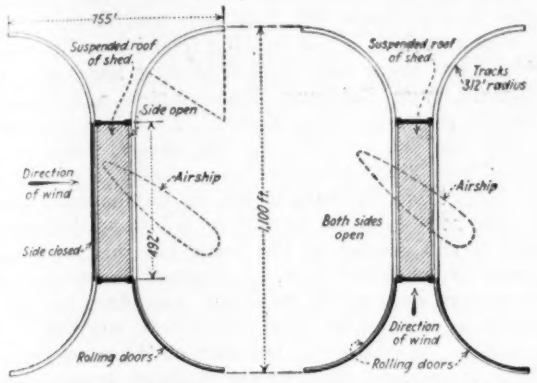


FIG. 4. ROLLING SIDES OF AIRSHIP SHED FORM WIND SHIELDS

mounted on platforms 36 x 22 ft., the sheathing being on the outer or inclined side of the frames.

Each platform is carried by trucks on a pair of tracks parallel with the shed and extending beyond it on curves of 308-ft. radius. In this way any part or the entire length of the side can be opened, free of any obstruction, to allow the airship to enter at any angle. Further, the doors can be so placed on the diverging tracks as to protect the movements of the airships from wind blowing in any direction, as shown by Fig. 4. The door panels or sections are operated by cables and electric hoists.

Equipment and Materials Being Assembled For Lining Hetch Hetchy Tunnels

Work is to start at once on the installation and operation of equipment for crushing muck from the Hetch Hetchy tunnels, which are being constructed on the San Francisco water supply project, to be used later in the concrete lining. The Construction Company of North America, general contractors on the tunnel work, have awarded a subcontract to the Universal Concrete Gun Co. for lining the 9 miles of tunnel between Priest and South Fork. The actual lining operations will not be begun until the tunnel is holed through, about Christmas of 1922, but meantime equipment and materials are to be assembled, particularly stock piles of crushed rock. Priest, Big Creek and Second Garrote are the three points from which lining operations will be carried on when lining operations start and where material storage piles are to be made meantime. The lining operations on this 9-mile stretch are expected to occupy five months after the tunnel is holed through. Specifications call for a minimum thickness of 6 in. of 1:2:4 concrete without reinforcement. The contract price was $14 per cubic yard, this figure to cover all costs including royalty on the Web and Cox concrete-placing machine which is to be used throughout. This machine, which moves the concrete by means of a piston operated by compressed air, is a California development of recent years which was described in *Engineering News-Record*, July 7, 1921, p. 14.

Concrete Block Track Supports on Italian Railways

Fixed and Rocking Blocks Placed Longitudinally Have Rail Seats at Each End—Rockers Insure Vertical Loading

LONGITUDINAL but non-continuous concrete supports for rails, with provision for transmitting a vertical load to the foundation under any position of the wheels, are the features of two types of railway track which has been in experimental service on steam and electric lines in Italy for a few years.

In the design for secondary lines and street railways, Fig. 1, flat blocks 40 x 20 in. on the base and 32 x 12 in. on top, with a thickness of 8.8 in., are spaced about 12 in. apart between their ends. Transverse tie rods have vertical ends grouted into holes in the blocks. A rail seat at each end of the block consists of a wood cushion resting on a base plate and carrying a tie-plate for the rail, the base plate being anchored to the concrete. Lugs or stops prevent lateral movement of the cushion. This arrangement and a simpler design for branch and secondary lines are shown in Fig. 1. In both cases the rail is held by bolts which are screwed down into nuts fitted to sockets in the concrete.

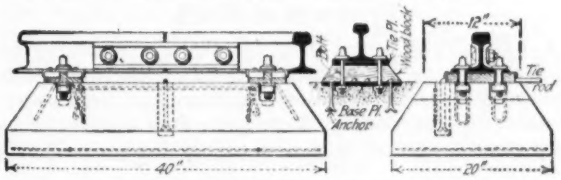


FIG. 1. LONGITUDINAL CONCRETE BLOCKS SUPPORT RAILS

As the blocks weigh about 400 lb. and give a weight of 1,000 lb. per yard of completed track, it is claimed that their vertical motion under traffic is negligible so that they cause no pumping of the ballast. Further, it is stated that some railways have decided to introduce these blocks first under rail joints. The cost of this construction is given as less than half that of ordinary track with wood ties and screened gravel ballast.

In the flexible or rocking design intended for heavy main line track, Fig. 2, the rail supporting blocks are about 29 x 9.6 in. with a depth varying from 7 in. at the ends to 14 in. at the middle. A steel plate bent to form a rocker is anchored to the apex of the block, and is seated on a steel channel embedded in the recessed face of a fixed foundation block 28 x 32 in. on the base and 8 in. thick. In this way, the latter block receives only a vertical load. Hook bolts secure the rocker to the foundation block. Longitudinal connection between the rockers is provided by flat bars hooked to the exposed ends of reinforcing bars and attached also to the rails, as shown. Transverse tie bars are secured to the rails instead of to the concrete blocks. Rail seats and fastenings are similar to those for the rigid track design. The upper and lower blocks weigh 264 and 400 lb. respectively, the weight per yard of completed track being about 2,400 lb., including the earth covering which is filled up to the rail base.

This flexible type of track is said to have been in use for 328 ft. on the Asti-Altavilla line since 1916, although that construction differs somewhat from the improved design shown in Fig. 2. It is stated that the rocking movement is so slight that no friction need be

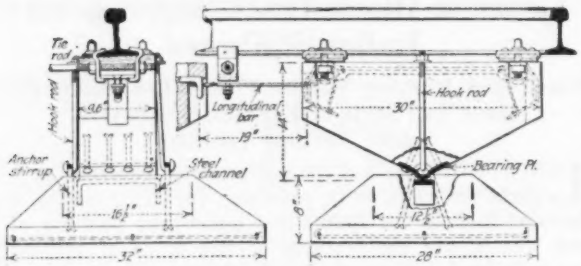


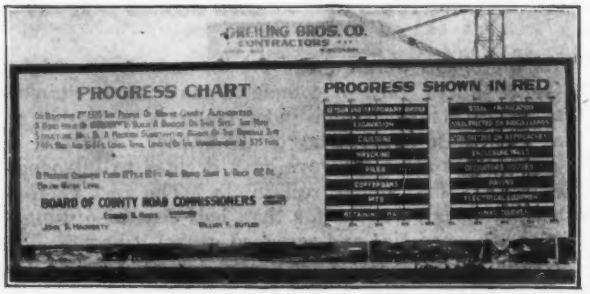
FIG. 2. ROCKING TRACK BLOCKS TRANSMIT VERTICAL LOAD

feared, the support being practically a knife edge. In fact, allowing for rust and dirt, since the blocks are buried, it may be doubted whether the rocking would occur in old track. Adjustment of surface in maintenance work is effected by shims or wedges under the rails.

These two track designs are the invention of O. Valeri, civil and electrical engineer, Rome, Italy, who has obtained United States patents.

Bulletin Board Posts Public on Progress of Work

A BULLETIN board progress chart is employed by the County Road Commissioners to keep the public informed of the construction progress on all large operations in Wayne County, Michigan. One of the "progress charts" erected at a new county bridge is shown



BULLETIN BOARD KEEPS PUBLIC INFORMED OF CONSTRUCTION PROGRESS

by the accompanying view. It is kept filled in with the necessary red paint ribbons showing progress, and stands where it may be seen by all who travel the detour around the bridge. These charts are considered by the Highway Commissioners to be a service which the public has a right to ask. They have been found to help also with the people in getting favorable consideration of improvements planned by the commissioners.

Tar Paper Over Subgrade

With the idea of reducing the cracking of concrete pavement on a clay subgrade, ½ mile of 18-ft. subgrade in Wayne County, Michigan, has been covered with ordinary tar-paper roofing laid with lap joints and carefully preserved from being broken through in placing the concrete. It is believed that the watertight diaphragm will keep moisture from the underside of the slab and may thus be a help in preventing cracks.

Railway Work in Queensland

LINKING up isolated lines of railway into a connected system and revising grades and curves to conform to present traffic conditions are railway developments now in progress in Queensland, Australia. The original policy was to divide the state into four districts and to develop each by a line running inland from its main port. Thus there were lines extending approximately westward from Brisbane, Rockhampton and Townsville and southwest from Cairns. Each had branches to open up the country, but for several years they formed four disconnected systems. Later, a coast line was built from Brisbane north to Rockhampton, and this has been extended at various points so that eventually it will connect all the ports, but this work was delayed by the World War. A diagonal line connecting the western ends of the principal main lines has been authorized, extending from Tobermory northwest to Camooweal, about 650 mi., but work on it has not begun.

The Queensland Government Railway system comprises 5,655 miles, with 6,000 miles of track and 700 miles of sidetrack, besides which there are 133 miles of private railways, the entire system being of 3½-ft. gage. Many of the pioneer lines were of light construction, with 41¼-lb. rails and engine loads limited to 8 tons per axle. For renewals, 60-lb. and 75-lb. rails are being used, the latter for the main lines entering the capital city of Brisbane. With the heavier rails, 12-ton axle loads were permitted, which necessitated strengthening the bridges, but all new bridge work is designed for engines of the 4:8:2 class with 15-ton axle loads.

As steep grades and 330-ft. curves were used freely in original construction, extensive revision work is being carried out to adapt the lines to present traffic conditions. On the new coast line the maximum grade is 1.33 per cent with a minimum curve radius of 792 ft. and transitions for all curves up to 1,320 ft. radius. By considering momentum as a factor in the rearrangement of grades the cost of this revision work has been reduced materially. Grading is done partly by elevating graders hauled by tractors. In October, 1920, about 1,625 men and 113 teams were employed in grading, mainly on extensions of the coast line.

Electrification of the Brisbane suburban lines has been considered, but the traffic conditions are not likely to warrant the change for some years. New locomotive and car shops are being built two miles from Brisbane, the old site in the city being utilized for a large freight terminal. The Central Station, for passenger service, is also to be improved and a new building erected for the offices of the Railway Commissioner and his staff. R. E. Sexton is chief engineer for railways.

Building Activity in New York Cities

According to figures compiled by the New York State Department of Labor, building authorizations in July for the principal cities in the state show a new high record for this year. The estimated value of building work for which permits were issued in July in the first and second-class cities of the state was $52,332,357. This amount is 21 per cent greater than that reported in June and slightly exceeds the previous record for this year established in May. Compared with the same month of last year, the value of authorized building work in July shows a gain of 113 per cent.

Precautions in Handling Liquid Chlorine

HAZARDS in the handling and storage of liquid chlorine together with methods of overcoming them were described in a paper presented recently to the National Safety Council Congress in Boston by D. K. Bartlett, vice president, Electro-Bleaching Gas Co. Chlorine shipments are regulated by The Interstate Commerce Commission rules and no accidents have occurred since the regulations have been put into effect. In addition to its use for water sterilization chlorine is used in the textile, flour, chemical and pulp-and-paper industries. It is stored at 4,000 to 5,000 different points in quantities up to many thousand pounds. No storage regulations are in force other than those recommended by the producer. Mr. Bartlett comments on the hazards and precautions as follows:

As long as any compressed gas remains in the container it is obvious that it can do no harm, irrespective of its effect when released. It is therefore necessary to consider the probability of escape of gas from the container, as well as the qualities of the gas itself. An escape of gas from a container may be due to (*A*) a true explosion, (*B*) an increase of pressure due to heat, sufficient to rupture the container and (*C*) leaks. If the gas escapes from the container, the resulting hazard may be due to (1) inflammability; (2) poisonous effects; (3) irritating effects, with interference with sight or respiration.

Considering now the specific case of chlorine, we can eliminate (*A*) since it is non-explosive. The chance of a rupture due to (*B*) is very slight on account of the high critical temperature of chlorine, 146 deg. Fahrenheit.

By Interstate Commerce regulation all cylinders and ton drums are provided with fusible plugs melting at 158 deg. *F*, at which temperature the pressure is about half the test pressure of ton drums at the time of manufacture and a quarter of the test pressure of the smaller cylinders. There has never been an instance of the bursting of a container in transit, or in a user's plant. Four or five cases of rupture of containers have occurred in the manufacturers' plant due to the presence of foreign material in the container which reacted with the chlorine. To guard against a repetition of such accidents, all manufacturers now have in force a rigid system of inspection of empty containers. Even should a container with such foreign material be filled, any trouble resulting will necessarily develop within a few hours, so that any hazard existing from this cause concerns only the manufacturer—not the user or the carrier.

Fires and Leaks

A few fires have been caused where a large quantity of chlorine has been stored. In each case the upward draft due to the heat of conflagration has been strong enough to carry the gas upward and cause such a dilution that the fire fighters were caused no inconvenience in their work.

This brings us to leaks. Here the evil smell of chlorine is its own greatest safety factor. Its presence in the atmosphere can be detected in very minute quantities through the sense of smell. After the person in charge of the use of the chlorine in any plant has had his first considerable whiff, he is quite ready—from then on—to exercise reasonable care, take necessary precautions and follow the instructions laid down by the manufacturer.

The next factor is the slow absorption of the heat necessary to evaporate the liquid into a gas. The following table gives the rise of temperature of the liquid chlorine in a tank car during a period of 96 hours:

Time	Temp. Content, Deg. C.	Change During Period, Deg. C.	Pressure, Lb.	Change During Period, Lb
(Start)	(—9)	...	(64)	.....
End 24 hr.	—2	7	76	12
End 48 hr.	+3.5	5.5	88	12
End 74 hr.	+6	2.5	93	5
End 96 hr.	+8.5	2.5	98	5

When the odor of chlorine is noticed the source should immediately be located. Never hunt a leak through the sense of smell. Always have a gas mask handy and be sure you have fresh canisters. The mask is not likely to be used, but it gives confidence to the one hunting the leak. Have a bottle of aqua-ammonia and a piece of waste fastened to the end of a short stick. Dip the waste into the ammonia and start your search. The moment you come to chlorine in the air, a white fume of ammonium chloride will appear. If this leak is in the piping, etc., shut off the valves at the containers and repair. If in a valve on the container or the container itself, and it cannot be stopped, connect the gas valve from the container to your absorption system and begin to operate. The liquid cannot evaporate in the containers, without the application of heat, as fast as the gas is absorbed in your system, and thus the leak quickly stops.

As to the properties of chlorine, it is non-inflammable, and not poisonous, in the sense that carbon monoxide or phosgene is poisonous. We can therefore eliminate risks (1) and (2) and confine ourselves to (3).

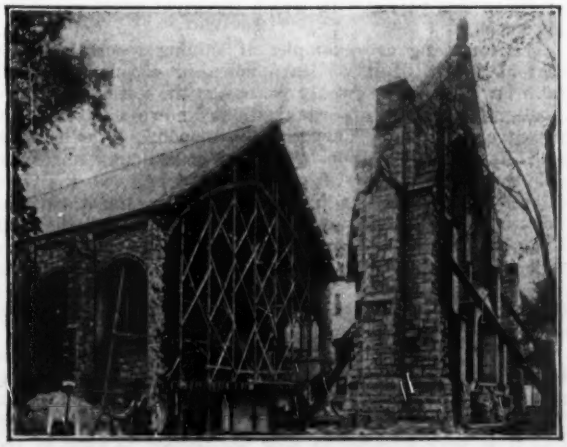
The immediate result of inhaling a large quantity of chlorine gas is the inflammation of the tissues lining the throat, with resulting coughing and nausea. While it is highly irritating and extremely uncomfortable, it is never fatal—unless the subject remains for a considerable period in an atmosphere of highly concentrated gas.

Should a person be affected by chlorine gas we recommend the following treatment: Remove the patient at once to the open air and away from all gas fumes. Place him flat on his back with head slightly elevated, and give a half teaspoonful of essence of peppermint, or a moderate dose of bromo-seltzer or whiskey. This will relieve the tendency to cough and soothe the inflamed membranes, allowing the passage of air and promoting the action of the respiratory organs. The person affected should himself resist as much as possible the impulse to cough. A mustard plaster on the chest will give prompt relief. While there are never any serious after-effects, a physician should always be called.

Part of Stone Church Moved 30 Ft. To Increase Seating Capacity

By Gus T. Britt
Gus Britt Company, House Movers, Buffalo, New York

IN ORDER to increase the seating capacity of the Central Presbyterian Church, Buffalo, New York, which is a stone structure, the front was cut away from the rest of the building, set on rollers and moved a distance of 30 ft. with the aid of screwjacks. That portion of the structure moved was 78 ft. wide, 65 ft. high and 8 ft. thick. The actual time required to move the front of the structure was sixteen hours. The work was done by the Gus Britt Company, housemovers of Buffalo.



FRONT OF STRUCTURE AFTER HAVING BEEN MOVED

The Engineer a Failure As a Manager

By Philip Cabot
Of White, Weld & Co., Bankers, Boston, Mass.

Abstract of an address before the joint meeting of the American Institute of Electrical Engineers, American Society of Civil Engineers, American Society of Mechanical Engineers and American Institute of Mining and Metallurgical Engineers, New York City, Oct. 19, 1921.

ESSENTIALLY the great engineer as born and trained in our times is of the scientific studious type, disciplined, severe, ascetic. By nature cool, cautious and fond of formulas, his schooling and the discipline of the professional career which follows teach him to curb his enthusiasms and emotions sternly, never to allow his hopes, fears or aspirations to influence his figures or color his conclusions, and after the most painstaking analysis of all his calculations he is wont to add 15% to 25% as a factor of safety.

Your builder and leader of great industrial enterprises is cast in a different mold. He is essentially an idealist, imaginative, enthusiastic, impulsive, intensely human, a dreamer of dreams with the power to make the dreams come true—in short an artist capable both of great imaginative conception, and fine technical execution; possessed of the power both to conceive and do. A glance at the history of American industry during the last fifty years will show that the great figures are all men of this type: Vanderbilt, Hill, Ripley, Carnegie, Schwab, Rosenwald, Woolworth, Armour, McCormick, Cudahy, McElwain, Endicott, Ford, Westinghouse, Coffin, Vail.

Reasons for Success

As one excellent example take Vail of the telephone company. Distinctly less remarkable than some of his predecessors in intellectual power, and scientific training he took the company when it seemed about to go upon the financial rocks and left it the most shining success of any public utility in the world, having steered it through the most difficult period for companies of this kind that we have ever known. His success was due, not to commanding intelligence but to imaginative power and the capacity to select and direct men. And look at our dear Henry Ford with all his sins of ignorance upon his head, who has, as it were overnight, leaped from nowhere into the multi-millionaire class. On most subjects his ignorance seems to be colossal, and one is almost tempted to think that he knows one thing only—human nature.

The reason why such men succeed is obvious. They have faith; they believe in things they cannot prove, possess the courage to stake their reputation and their future on their ability to make their dreams come true, and obtain from these qualities the power to inspire with enthusiasm and loyalty the great bodies of men under their command who are their necessary tools, controlling them with the precision and power with which the great painter handles his brush.

The foregoing are examples of shining success and the reasons for it. But we learn more, as a rule, from our failures. Fifteen or twenty years ago the nation witnessed a magnificent crop of organizations known as trusts, designed often for the purpose of monopolizing the market, shutting out competition, and thereby realizing unreasonable profits. I fancy it is generally believed that the failure of the great majority of these organizations was due to governmental action, but such was not the fact. The ones that failed bore the seeds of failure within themselves. The men who organized and led them had a false vision of the market, the customer and the public, and they were wholly lacking in the vision, enthusiasm and courage which are essential to successful leadership.

But perhaps the most striking illustration which we have today of failure is in the railroad business. Many reasons are assigned for the collapse of the railroads, and like all other human things, there is doubtless no one cause. But it is very striking to note the change in type of the men who now lead the great railroad systems as compared with the men who led them when they were successful. In the earlier days our great railroad leaders were primarily traffic men—men whose vision naturally focussed upon the market, who saw the thing to be done and found some way to do it. Now, the leaders of our great railroad systems are all operating men; in other words, essentially men of engineering training and the scientific type.

It is doubtless true that whatever the ability of these men might have been, success has been made impossible by the systems of regulation under which they have been placed. Holding the ignominious position of responsibility without power, it is no wonder if they have failed in successful leadership. But it is undeniable that they have failed conspicuously. The huge army which these men command, far from being inspired by the enthusiasm and loyalty which are essential to success, is admittedly upon the verge of mutiny. For years the relation of the great railroad executives to their employees has been such as to breed disloyalty. The effect of government regulation as designed and administered during the last 20 years has been to develop in railway executives and in leaders of the great railway unions the most conspicuous and magnificent example which the world has ever seen of the great game of "pass the buck."

Training Natural Handicap

In all great operations whether new or old the leading dominating spirit must be that of the idealist, the promotor, the great salesman, rather than the student or man of science. Such an attitude of mind is very difficult for the typical engineer both on account of his temperament and his training. His natural position is that of the hand which executes rather than the mind that conceives. Leadership is not native to him, his enthusiasms have been put under stern control; locked up so that they cannot warp his judgment, they cannot easily be released to inspire others. In fact, they are often atrophied.

I do not say, nor do I believe, that it is impossible for an engineer to be a great leader and manager of industry. All that I can maintain is that his natural handicap is increased by our present methods of training to such an extent as to make him an unpromising candidate for promotion to such positions, and I say this with full knowledge of the fact that his selection to fill them has become increasingly common of late years especially in public service corporations.

The Engineer's Opportunity

If this fact seems to you extraordinary the reason is not far to seek. The directors and officers of corporations are in theory elected by the owners (to wit, the stockholders), but nothing is farther from the fact. Stockholders are in practice a flock of sheep incapable of concerted, intelligent action but eager to follow any leader, so that the task of selecting corporation managements falls upon the banker, or financial godfather of the enterprise. Such men, cautious by nature, and made doubly so by experience, yearn for a sure thing and welcome the engineer with his mathematical accuracy. Your engineer *at least* will not exceed his estimates, will tell them in advance what he will do and do it, while your most visionary promotor must forever be watched and guided. With an engineer at the wheel the company will run itself and the banker and director can sleep in peace. But there is apt to be a rude awakening when he discovers that the business has gradually evaporated, wages have shown a disconcerting tendency to eat up profits, and customers are becoming surly.

In this case, as in all others, the search for the sure thing fails; temporary peace is purchased at the cost of the ultimate failure and the practice must be abandoned. The bankers must select men of enthusiasm, courage and vision, and must put over them boards of directors who are capable and willing to direct. Your dreamer without direction will wreck you faster and more certainly than your man of science. But with adequate direction and control he is your safest man; and if our engineers are to occupy such positions with success their education and training must be profoundly modified.

Tables for Designing Non-Pressure Water and Sewer Tunnels

By Julian Hinds

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A PAPER on the "Hydraulic Jump and Critical Depth in the Design of Hydraulic Structures" was presented by me in *Engineering News-Record*, Nov. 25, 1920, p. 1034. Inquiries subsequently received indicate that the principles outlined may have an important bearing upon the design of water-supply and sewage non-pressure tunnels.

Where horse-shoe or circular cross-sections are used the labor of testing for the critical depth or the hydraulic jump is materially reduced by use of the tables submitted herewith. These tables are intended to supplement tables of "Areas, Wetted Perimeter, and Hydraulic Radius of Circular and Horse-shoe Conduits," by George Henry Ellis, published in *Engineering News*, June 17, 1915, p. 1182.

Suppose that it is desired to find the critical depth for 650 sec.-ft. flowing free in a 9-ft. diameter circular conduit. $Q/D^{5/2} = 650/243 = 2.675$. Entering Table I, column 3, with this value, the corresponding value of d/D is found to be 0.701. The critical depth

TABLE I. VELOCITY HEAD AND DISCHARGE AT CRITICAL DEPTHS AND STATIC PRESSURES IN CIRCULAR CONDUITS PARTLY FULL

$\frac{d}{D}$	$\frac{hv}{D}$	$\frac{Q}{D^{\frac{5}{2}}}$	$\frac{P}{D^3}$	$\frac{d}{D}$	$\frac{hv}{D}$	$\frac{Q}{D^{\frac{5}{2}}}$	$\frac{P}{D^3}$	$\frac{d}{D}$	$\frac{hv}{D}$	$\frac{Q}{D^{\frac{5}{2}}}$	$\frac{P}{D^3}$
1	2	3	4	1	2	3	4	1	2	3	4
0.01	0.0033	0.0006	0.0000	0.34	0.1243	0.6657	0.0332	0.67	0.2974	2.4464	0.1644
0.02	0.0067	0.0025	0.0000	0.35	0.1284	0.7040	0.0356	0.68	0.3048	2.5182	0.1700
0.03	0.0101	0.0055	0.0001	0.36	0.1326	0.7433	0.0381	0.69	0.3125	2.5912	0.1758
0.04	0.0134	0.0098	0.0002	0.37	0.1368	0.7836	0.0407	0.70	0.3204	2.6656	0.1816
0.05	0.0168	0.0153	0.0003	0.38	0.1411	0.8249	0.0434	0.71	0.3286	2.7414	0.1875
0.06	0.0203	0.0220	0.0005	0.39	0.1454	0.8671	0.0462	0.72	0.3371	2.8188	0.1935
0.07	0.0237	0.0298	0.0007	0.40	0.1497	0.9103	0.0491	0.73	0.3459	2.8977	0.1996
0.08	0.0271	0.0389	0.0010	0.41	0.1541	0.9545	0.0520	0.74	0.3552	2.9783	0.2058
0.09	0.0306	0.0491	0.0013	0.42	0.1586	0.9996	0.0551	0.75	0.3648	3.0607	0.2121
0.10	0.0341	0.0605	0.0017	0.43	0.1631	1.0458	0.0583	0.76	0.3749	3.1450	0.2185
0.11	0.0376	0.0731	0.0021	0.44	0.1676	1.0929	0.0616	0.77	0.3855	3.2314	0.2249
0.12	0.0411	0.0868	0.0026	0.45	0.1723	1.1410	0.0650	0.78	0.3967	3.3200	0.2314
0.13	0.0446	0.1016	0.0032	0.46	0.1769	1.1899	0.0684	0.79	0.4085	3.4112	0.2380
0.14	0.0482	0.1176	0.0038	0.47	0.1817	1.2399	0.0720	0.80	0.4210	3.5050	0.2447
0.15	0.0517	0.1347	0.0045	0.48	0.1865	1.2908	0.0757	0.81	0.4343	3.6019	0.2515
0.16	0.0553	0.1530	0.0053	0.49	0.1914	1.3427	0.0795	0.82	0.4485	3.7021	0.2584
0.17	0.0589	0.1724	0.0061	0.50	0.1964	1.3955	0.0833	0.83	0.4638	3.8061	0.2653
0.18	0.0626	0.1928	0.0070	0.51	0.2014	1.4493	0.0873	0.84	0.4803	3.9144	0.2723
0.19	0.0662	0.2144	0.0080	0.52	0.2065	1.5041	0.0914	0.85	0.4982	4.0276	0.2794
0.20	0.0699	0.2371	0.0091	0.53	0.2117	1.5598	0.0956	0.86	0.5177	4.1465	0.2865
0.21	0.0736	0.2609	0.0103	0.54	0.2170	1.6164	0.0998	0.87	0.5392	4.2721	0.2938
0.22	0.0773	0.2857	0.0115	0.55	0.2224	1.6735	0.1042	0.88	0.5632	4.4056	0.3011
0.23	0.0811	0.3116	0.0128	0.56	0.2279	1.7327	0.1087	0.89	0.5900	4.5486	0.3084
0.24	0.0848	0.3386	0.0143	0.57	0.2335	1.7923	0.1133	0.90	0.6204	4.7033	0.3158
0.25	0.0887	0.3667	0.0157	0.58	0.2393	1.8530	0.1179	0.91	0.6555	4.8725	0.3233
0.26	0.0925	0.3957	0.0173	0.59	0.2451	1.9146	0.1227	0.92	0.6966	5.0603	0.3308
0.27	0.0963	0.4259	0.0190	0.60	0.2511	1.9773	0.1276	0.93	0.7459	5.2726	0.3384
0.28	0.1002	0.4571	0.0207	0.61	0.2572	2.0409	0.1326	0.94	0.8065	5.5183	0.3460
0.29	0.1042	0.4893	0.0226	0.62	0.2635	2.1057	0.1376	0.95	0.8841	5.8118	0.3537
0.30	0.1081	0.5225	0.0255	0.63	0.2699	2.1716	0.1428	0.96	0.9885	6.1787	0.3615
0.31	0.1121	0.5568	0.0266	0.64	0.2765	2.2386	0.1481	0.97	1.1410	6.6692	0.3692
0.32	0.1161	0.5921	0.0287	0.65	0.2833	2.3067	0.1534	0.98	1.3958	7.4063	0.3770
0.33	0.1202	0.6284	0.0309	0.66	0.2902	2.3760	0.1589	0.99	1.9700	8.8203	0.3848
.....	.....	.....	.....	.....	.....	.....	.....	1.00	.....	.....	0.3927

D = Diameter of circle.
d = Depth of water.
hv = Velocity head for a critical depth of d.
Q = Discharge when the critical depth is d.
P = Pressure on cross section of water prism in cubic units of water. To get P in pounds, when d and D are in feet, multiply by 62.5.

TABLE II. VELOCITY HEAD AND DISCHARGE AT CRITICAL DEPTHS AND STATIC PRESSURES IN HORSESHOE CONDUITS PARTLY FULL

$\frac{d}{D}$	$\frac{hv}{D}$	$\frac{Q}{D^{\frac{5}{2}}}$	$\frac{P}{D^3}$	$\frac{d}{D}$	$\frac{hv}{D}$	$\frac{Q}{D^{\frac{5}{2}}}$	$\frac{P}{D^3}$	$\frac{d}{D}$	$\frac{hv}{D}$	$\frac{Q}{D^{\frac{5}{2}}}$	$\frac{P}{D^3}$
1	2	3	4	1	2	3	4	1	2	3	4
0.01	0.0033	0.0009	0.0000	0.34	0.1427	0.8421	0.0421	0.67	0.3208	2.7402	0.1877
0.02	0.0067	0.0035	0.0000	0.35	0.1472	0.8854	0.0449	0.68	0.3283	2.8155	0.1937
0.03	0.0100	0.0079	0.0001	0.36	0.1518	0.9296	0.0478	0.69	0.3362	2.8922	0.1999
0.04	0.0134	0.0139	0.0002	0.37	0.1563	0.9746	0.0508	0.70	0.3443	2.9702	0.2062
0.05	0.0168	0.0217	0.0004	0.38	0.1609	1.0205	0.0540	0.71	0.3528	3.0499	0.2125
0.06	0.0201	0.0312	0.0007	0.39	0.1655	1.0673	0.0572	0.72	0.3615	3.1311	0.2190
0.07	0.0235	0.0425	0.0010	0.40	0.1702	1.1148	0.0605	0.73	0.3707	3.2140	0.2255
0.08	0.0269	0.0554	0.0014	0.41	0.1749	1.1633	0.0639	0.74	0.3802	3.2987	0.2321
0.09	0.0305	0.0703	0.0018	0.42	0.1795	1.2125	0.0675	0.75	0.3902	3.3853	0.2385
0.10	0.0351	0.0879	0.0024	0.43	0.1843	1.2626	0.0711	0.76	0.4006	3.4740	0.2457
0.11	0.0397	0.1069	0.0030	0.44	0.1890	1.3135	0.0748	0.77	0.4116	3.5650	0.2525
0.12	0.0443	0.1272	0.0037	0.45	0.1938	1.3652	0.0786	0.78	0.4232	3.6584	0.2595
0.13	0.0489	0.1487	0.0045	0.46	0.1986	1.4178	0.0825	0.79	0.4354	3.7544	0.2666
0.14	0.0534	0.1714	0.0054	0.47	0.2035	1.4712	0.0865	0.80	0.4484	3.8534	0.2737
0.15	0.0579	0.1953	0.0063	0.48	0.2084	1.5253	0.0907	0.81	0.4623	3.9557	0.2809
0.16	0.0624	0.2203	0.0074	0.49	0.2133	1.5803	0.0949	0.82	0.4771	4.0616	0.2882
0.17	0.0669	0.2465	0.0085	0.50	0.2183	1.6361	0.0992	0.83	0.4930	4.1716	0.2956
0.18	0.0714	0.2736	0.0098	0.51	0.2234	1.6928	0.1036	0.84	0.5102	4.2863	0.3030
0.19	0.0758	0.3019	0.0111	0.52	0.2285	1.7505	0.1081	0.85	0.5289	4.4063	0.3105
0.20	0.0803	0.3312	0.0125	0.53	0.2337	1.8092	0.1127	0.86	0.5494	4.5325	0.3181
0.21	0.0847	0.3615	0.0140	0.54	0.2391	1.8688	0.1174	0.87	0.5719	4.6660	0.3258
0.22	0.0891	0.3928	0.0156	0.55	0.2445	1.9294	0.1223	0.88	0.5969	4.8080	0.3335
0.23	0.0936	0.4251	0.0173	0.56	0.2500	1.9911	0.1272	0.89	0.6251	4.9605	0.3413
0.24	0.0980	0.4583	0.0191	0.57	0.2557	2.0537	0.1322	0.90	0.6570	5.1256	0.3492
0.25	0.1024	0.4926	0.0210	0.58	0.2615	2.1174	0.1373	0.91	0.6939	5.3065	0.3572
0.26	0.1069	0.5277	0.0229	0.59	0.2674	2.1821	0.1425	0.92	0.7371	5.5077	0.3653
0.27	0.1113	0.5638	0.0250	0.60	0.2735	2.2479	0.1478	0.93	0.7889	5.7354	0.3733
0.28	0.1158	0.6009	0.0271	0.61	0.2797	2.1348	0.1532	0.94	0.8528	5.9996	0.3813
0.29	0.1202	0.6389	0.0294	0.62	0.2861	2.3828	0.1587	0.95	0.9345	6.3157	0.3894
0.30	0.1247	0.6777	0.0317	0.63	0.2926	2.4519	0.1643	0.96	1.0446	6.7114	0.3976
0.31	0.1292	0.7175	0.0342	0.64	0.2994	2.5221	0.1700	0.97	1.2053	7.2417	0.4058
0.32	0.1337	0.7582	0.0367	0.65	0.3063	2.5936	0.1758	0.98	1.4742	8.0392	0.4140
0.33	0.1382	0.7997	0.0393	0.66	0.3134	2.6663	0.1817	0.99	2.0804	9.5780	0.4223
.....	.....	.....	.....	.....	.....	.....	.....	1.00	.....	.....	0.4306

D = Diameter of horseshoe.
d = Depth of water.
hv = Velocity head for a critical depth of d.
Q = Discharge when the critical depth is d.
P = Pressure on cross section of water prism in cubic units of water. To get P in pounds, when d and D are in feet, multiply by 62.5.

is therefore $d = 9 \times 0.701 = 6.31$. The critical velocity head is likewise found to be $hv = 0.3214 \times 9 = 2.893$, which gives a critical velocity of $V = 13.63$. This information determines whether the flow at a given point is above or below the critical depth, and provision may be made for any contingency likely to occur.

Column 4 gives the hydrostatic pressure upon the cross section of the water prism. The tabular values must be multiplied by D^3 to give pressures in cubic units of water. The pressures thus found are equivalent to the term P used in constructing the $(Q/g \times V) + P$ curves in the discussion of the hydraulic jump, above referred to. These curves furnish a means for determining the height and location of the jump. If the pressure is required in pounds, multiply the tabular value by $62.5\ D^3$.

Table II is identical with Table I, except that it is computed for a horseshoe section of the proportions indicated. Tables for other forms of conduit can readily be prepared.

Temporary and Permanent Garbage Disposal Methods at Baltimore

UNTIL the contract for garbage disposal by reduction entered into between the city of Baltimore and the Sanitary Reduction Co. goes into effect on Jan. 1, the garbage of the city will be disposed of by burial at the site of the old hog-feeding plant on Bodkin Creek. This work is being done by city forces under the direction of the highways engineer, who assumed charge of it on Sept. 1. After transportation by scows the garbage is transferred by a gasoline-operated crane into industrial railway cars and hauled about 1,000 ft. to the burial site.

Trenches for burial are being excavated to a depth of about 4 ft. and a width of about 12 ft., by means of a small steam shovel, which also covers the garbage immediately after being dumped, with from 1 to 3 ft. of sandy loam from the excavation.

The amount of garbage buried in September averaged about 340 cu.ft. or 220 tons per day. The cost of burial in that month approximated $1 per cu.yd. or about $0.65 per ton, including unloading from scows and hauling to the trench. This takes into consideration the fuel used and the rental of a small steam shovel, but it does not consider interest or depreciation on the crane and industrial railway, which are owned by the city.

At the start, the burial trenches were 2 ft. deep and 5 ft. wide. Experience indicated the wisdom of a wider and deeper trench and it is proposed to experiment with a trench 25 ft. wide.

The adoption of garbage disposal by reduction is in accordance with the report by Henry G. Perring, chief engineer, Department of Public Improvements, summarized briefly in our issue of April 21, 1921, p. 698, except that a city-owned garbage reduction plant was recommended in the report. Mr. Perring informs *Engineering News-Record* that it was finally decided to have the garbage disposed of by contract instead of by the city direct since, in order to finance a city-owned plant, it would have been necessary to get authorization from the state legislature of 1922 and then to secure approval by referendum vote. The matter was considered too pressing to wait that long.

Accordingly, bids for disposal by contract were invited. Besides the bid from the Sanitary Reduction Co. (John T. Daily, president, Central Savings Bank Building, Baltimore), one was received from William F. Huse for disposal by burial at a cost to the city of $1.50 per ton. The accepted bid, from the Sanitary Reduction Co., was for $2.70 per ton, to be paid by the city to the contractor, the city guaranteeing to supply not less than 40,000 tons of garbage each year. The engineers of the Department of Public Improvements of Baltimore unanimously recommended that the award be made for disposal by reduction. The contract becomes effective Jan. 1, 1922, and runs for ten years. The city is to deliver the garbage to the reduction plant, which is located on Bodkin Creek, about 11 miles below the city, immediately across the creek from the old hog feeding plant.

The Sanitary Reduction Co. is building a new plant to use the Arnold-Edgerton process. The garbage will be unloaded from the scows by steam-operated grab buckets, which will dump into a hopper, feeding a trough conveyor, which will convey the garbage from the wharf up and over the top of the digestors. There will be 28 digesters, each with a capacity of ten tons. They will be brick lined and the vents will run into a collector pipe, connected with a jet condenser to prevent the digester fumes from spreading over the plant and in the community. Live steam from a battery of six 125-hp. return tubular boilers will be injected into the digesters and cooking continued about eight hours, at which time the digesters will be discharged by gravity into seven receiving tanks, one tank for a group of four digesters. Each receiving tank will feed an Edgerton roll press. The pressed tankage will be moved by a belt conveyor to scows for disposal as fertilizer base.

The liquid pressed out by the rolls will flow through gutters to catch basins, where the grease will be skimmed off and further refined by heat, after which it will be barrelled and disposed of commercially. The water remaining in the catch basin will be passed though sand filters before its final discharge. The fine solids remaining in the bottom of the catch basin will be run through screw presses to recover the tankage, while the grease removed by this process will be recovered in catch basins similar to those previously mentioned.

The mechanical plant will be housed in one large, well-lighted, structural steel building, which is the property of the Sanitary Reduction Co., and was previously used for a similar purpose. The plant is located on a 100-acre tract with adequate wharfage, owned by the company.

City Planning Proposed for Canton, China

Sun Fo, mayor of Canton, China, has written to the mayor of San Francisco asking for maps of the larger cities and other material bearing upon "schemes of street planning, drainage, sewerage, playgrounds, civic centers, water supplies, bridges, water fronts, electric lights, street illumination and tramway systems, etc.," which would be of assistance in "remodeling the city of Canton along modern lines." This opportunity for remodeling has arisen, the letter states, "in consequence of the recent demolition of our old city wall." The letter is published in full in the October *National Municipal Review* (New York City) in the hope that its publicity in this country will lead representatives of other cities than San Francisco to send helpful material to Mayor Sun Fo.

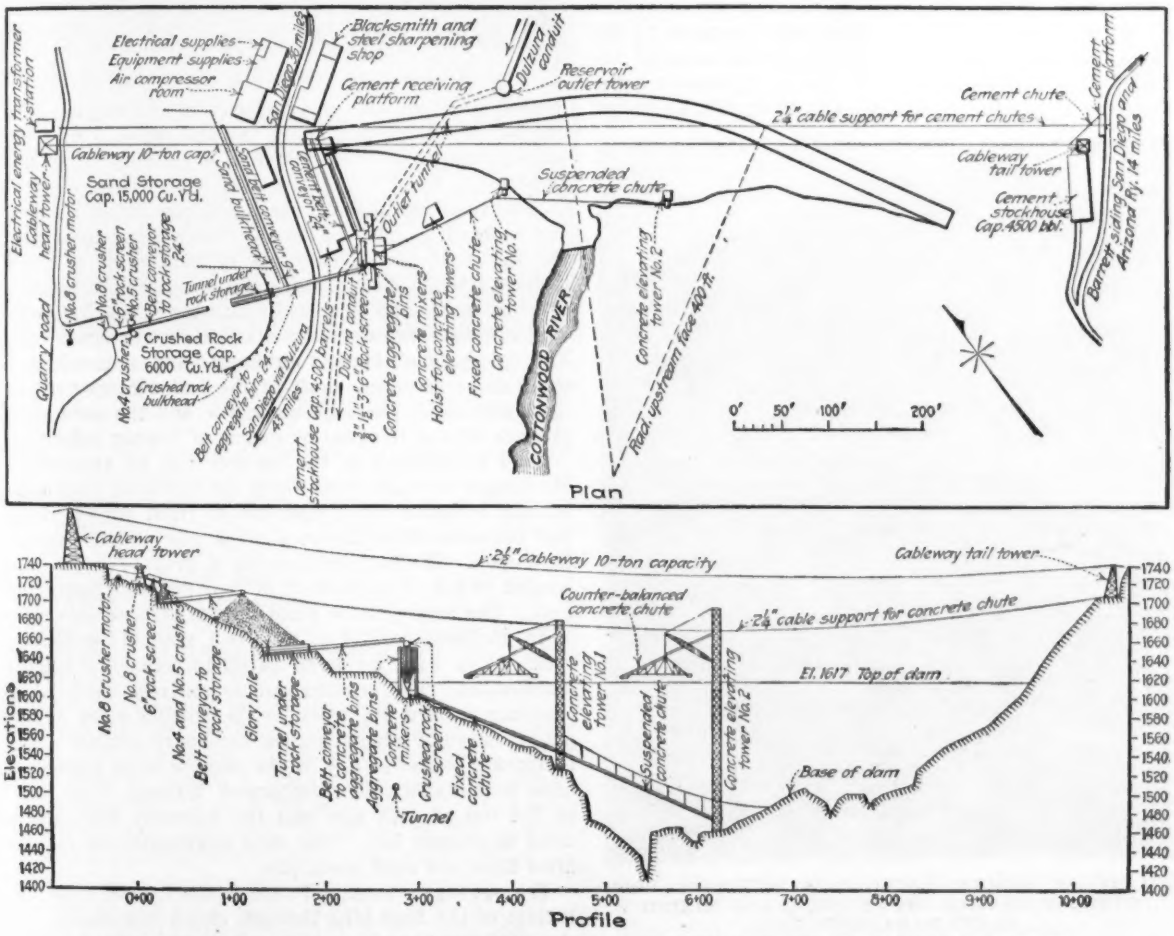
Proportioning and Making Concrete on Barrett Dam

Material Transported from Quarry at Damsite by Gravity Through Mixer to Dam — Unusually Large Aggregate Used in Predetermined Percentage of Four-Sized Aggregate

By H. N. Savage
Hydraulic Engineer, City of San Diego, San Diego, Cal.

In the construction of the Barrett Dam for the City of San Diego, Cal., special attention is being paid in the concrete to the selection of materials, sizing, proportioning, production and delivery. A quarry has been opened up in a granite formation nearby, the quarry floor being about 400 ft. above the level of damsite, from which the rock for concrete aggregate is being obtained, crushed, stored and delivered to the mixers, all in a horizontal distance of about 1,000 ft. A prominent feature of the concrete is the use of a predetermined per cent of four-sized aggregate, the larger size automobile trucks. It will be a gravity, arched type, concrete structure, 215 ft. high above lowest foundation, with 24 ft. deeper pressure grouting; 750 ft. long on top, forming a reservoir with maximum depth of 170 ft. and maximum length of four and one-half miles. The concrete masonry will total about 136,000 cu.yd., and the reservoir capacity 14¼ billion gallons.

Preliminary operations were started in October, 1919, just prior to a municipal bond issue of $1,000,000 which was voted Nov. 25, 1919. Work with bond funds was begun Feb. 1, 1920. Up to Aug. 1, 1921, a total of



PLAN AND PROFILE OF CONCRETING PLANT FOR BARRETT DAM, SAN DIEGO WATER SUPPLY

passing a 6 in. screen, some of the individual pieces running in longest dimension as high as 14 in., all being run through the mixers and chutes to place in the masonry.

The Barrett Dam, being constructed by the City of San Diego with city forces, is located on the Cottonwood River 36 miles easterly from San Diego, the distance by highway being 43 miles. Carload shipments move 67 miles by rail and continue 14 miles back by 60,000 cu.yd. of excavation for foundation had been taken out and 70,000 cu.yd. of concrete had been placed.

The quarry is located adjacent to and downstream from the right end of the dam. The quarry floor has an elevation of about 400 ft. above the original streambed. The rock is typical granite of about average grain and hardness, well suited for crushing and, when crushed, for concrete aggregate. Initial quarry drilling is accomplished with a 6-in. blast-hole oil-well drill-

ing machine. The alignment of the holes is parallel with the quarry face and spaced about 30 ft. back from the average face of quarry; the holes have an average depth of about 115 ft. and are spaced about 20 ft. centers. A battery of about 6 holes are usually drilled for a shot. The rock is transported to the crusher by means of all steel high two-wheeled one-horse carts, each using successively about five underhung, detachable skips, each skip having a capacity of 1½ cu.yd. solid measurement.

A No. 8 crusher installed adjacent to the quarry floor, immediately above the end of the dam, is the first unit of a continuous concreting plant which produces and delivers the concrete to place in the structure. The layout of the construction plant and the stages in the process of construction and preparation and transporting materials are indicated on the accompanying drawing.

These stages are, successively, as follows: First, a No. 8 crusher, the crusher run material from which passes 6-in. round holes in 48-in. circular screen and is delivered by gravity onto a 24-in. belt conveyor to the rock aggregate stock pile. The oversized material rejected by the screen adjacent to the No. 8 crusher automatically passes by gravity to a secondary No. 4 crusher

QUARRY IN MIDDLE BACKGROUND SUPPLIES ROCK WHICH RUNS THROUGH CRUSHING AND MIXING PLANT TO BARRETT DAM

which is set to produce the predetermined per cent of the smaller sized rock required and delivered by gravity also to the same 24-in. belt conveyor.

About one-half of the total sand required is furnished by the crusher run. The balance of the sand is obtained from natural deposits in the floor of the reservoir, is loaded with mobile, power elevators and hauled in automobile trucks up to the quarry floor and is either dumped into and passes through the initial crusher onto the 24-in. belt conveyor running to the rock stock pile, or is dumped into a sand stock pile

QUARRYING CONCRETE AGGREGATE

located adjacent to the crusher run stock pile. The crusher run stock pile has a storage capacity of 5,000 cu.yd.; the sand stock pile has a capacity of 15,000 cu.yd.

Sand required to finish the job is now being salvaged and stocked in advance of the winter drainage basin runoff. A 24-in. belt conveyor is installed in a tunnel underneath the rock stock pile taking supply through a "glory hole" and discharges into the 48-in. by 40-ft.-long circular screen over the concrete aggregate bins. The "glory hole" feed is automatic and actuated by a chain drive from the shaft of the belt conveyor at the stock pile end. The rock stock pile and the sand stock pile are limited in areas by means of timber bulkheads.

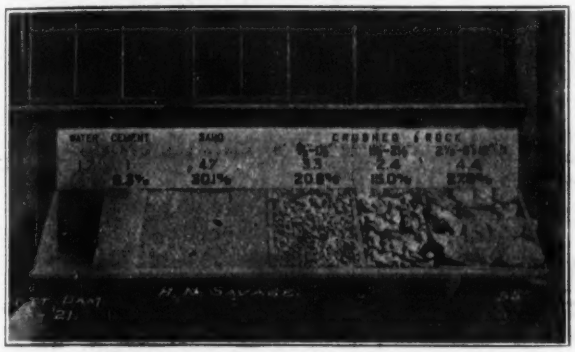
Sand in addition to the crusher run as required is discharged through ports along the bulkhead onto a 12-in. belt conveyor which operates at right angles to the belt conveyor from the rock stock pile and discharges thereupon. The individual sizing aggregate screens are located on top of the battery of four separate aggregate bins. The aggregate is sized by the screens into sand (⅜ in. and less) rock (⅜ in. to 1¼ in.), rock (1¼ to 2½ in.), rock (2½ to 6 in., by up to 14 in. in occasional longest dimension.) The crusher run is entirely used. Any tendency toward deficiency in the smaller sized aggregate is cured by regulating the secondary crusher. Any temporary excess in any of the smaller sized aggregate bins is automatically discharged through side ports at the top of each bin into the adjacent next larger sized aggregate bin. The sand aggregate bin is kept filled from the sand stock pile.

The aggregate rock and sand is discharged from the bottom of the four bins through closed box chutes and the predetermined per cent of individual sized aggregate measurement is accomplished by means of a receiving box with partitions spaced as required. The discharge from the chutes is controlled by a bin gate actuated with hydraulic pressure. Cement is introduced through an independent chute. The material is charged from the measuring hopper into the mixers as required, control being by means of another hydraulic actuated bin gate.

A battery of two 81 cu.ft. capacity, dry measure, mixers has been installed. So far it has been necessary to use only one mixer at a time, although a deflecting

gate is installed by means of which discharge from the hopper may be alternately diverted to either mixer. The concrete after being fully charged into the mixer is required to be retained in the mixer and mixed for a minimum of one full minute and no less period of mixing is permitted. A time clock is installed directly in front of the mixer operator and sufficient engineering inspection is maintained to insure a full minute minimum mix of every single batch. Notwithstanding the unusual size of the mass aggregate being used and mixed in the mixers and transported in the chutes, no disastrous wear has occurred. The lining and vanes in the mixers require frequent replacing but this work is performed by the mechanics on the job, thick, common steel plate being used.

After being discharged from the mixers, the concrete flows down a fixed 20-in. chute, of wood, steel lined, on



A CONTINUAL EXHIBIT OF CONCRETE PROPORTIONS

At Barrett Dam this set of bins is kept outside the engineers' office as an object lesson to the workmen and visitors of the ingredients which go to make up the mass concrete of the dam.

a 1 to 2½ slope and is discharged through movable steel chutes by gravity into place in the masonry. It is also sent by means of side gates alternately as required into elevating hoppers in either of the two concrete elevating towers. A considerable portion of the concrete in the base of the dam was poured by gravity without requiring to be hoisted in the towers. The movable chutes are 16 in. in size and bottom wear is provided for by lining the chutes; the lining lasting for about 12,000 yd. of concreting.

The concrete is proportioned by the Fuller and Abrams methods, with such modifications as are found to be desirable in the interests of workability, the object being to obtain a concrete of maximum density from the materials available, within the limits of workability of these materials. As an aid, all the aggregate crushing handling and concrete machinery is dust jacketed to retain the fine particles of the crusher run, the portion of the sand supply obtained from natural deposits being somewhat deficient in fine material.

Only the minimum amount of water required to permit the concrete being handled with chutes is used. The resulting concrete has proved uniformly workable and satisfactory; it arrives at place in the dam thoroughly mixed, without excess water and does not separate but remains homogeneous. To facilitate chuting the dryest practicable concrete, one or more laborers continuously ride the chutes and prevent clogging.

The amount of cement required is determined by frequent tests of 8- x 14-in. cylinders made of concrete taken from the chutes beyond the mixers. This size of specimen is used instead of the standard 8 x 16 in. size on account of the limitation in vertical clearance between the heads of the testing machine. Sufficient cement only is used to produce a 28-day compressive strength averaging about 1,650 lb. per sq. in. In molding the test specimens, the aggregate above 2½ in. in size is rejected as this is considered the maximum size suitable for use in a test specimen of this diameter.

Tests, however, with substitution for the rejected rock of an equal amount of material below the 2½ in. limiting size, show approximately the same strength at the 28-day period, and lead to the conclusion that the test cylinders give a fair indication of the compressive strength of the masonry of this age in mass. A representative grading of the aggregates, showing proportions of the several sizes, and including cement and water is shown in the accompanying view of an exhibition bin, which is maintained in front of the technical office at all times for the information of the public. The cement content is varied as warranted by the increasing strength and hardness of the quarry rock, as development of the quarry progresses, with a view to maintaining practically a constant average unit compressive strength as indicated above. The water content is varied as required by the moisture in the sand and the temperature of the air.

Following is a typical estimated cost of masonry.

	Per Cu. Yd.
Cement (delivered to mixers)	$3.46
Labor (mixing and placing)	.40
Labor (forms)	.20
Form lumber, wire and materials	.08
Crushed rock (delivered to bins at mixing plant)	1.08
Sand (delivered to bins at mixing plant)	.37
Blacksmith shop, operation and maintenance	.05
Electrical energy (concrete mixing and placing)	.10
Repairs and plant maintenance	.10
Grout washing	.03
Superintendence and unclassified	.08
General expense and engineering	.25
Total (exclusive of plant charges)	$6.20

W. A. Stebbins is construction engineer, resident on the job. S. R. Nelson is chief clerk in charge of mess, dormitory and clerical work. Purchasing is handled by the Municipal Purchasing Bureau, E. D. Williams, superintendent. The writer is in charge of the project.

Decision Against Antioch in Suit Over Brackish Water

The California Supreme Court, on Sept. 14, reversed the decision of the Alameda County Superior Court and dissolved the injunction granted last January to the town of Antioch restraining irrigators, including certain irrigation districts, from diverting water from the Sacramento River in quantities that would reduce the flow of that river at Antioch to an amount less than 3,500 sec.-ft. A resume of the case and the decision of the lower court appeared in *Engineering News-Record*, Mar. 24, p. 513. The Supreme Court decision holds that Antioch, as a mere appropriator of water from the river at a point near its outlet to the sea, does not acquire the right to insist that subsequent appropriations above shall leave enough water flowing in the stream to hold back the incoming tide to a point below the city's diversion. The case was declared to be unprecedented in that the plaintiff does not contend that anything is placed in the stream by the defendants that effects the purity of the water, but rather that the irrigators, by taking water from the river, (an act which is within their legal right), have caused more salt water to reach the vicinity of Antioch than would have reached it had there been no depletion of the

Henry Ford Gives His Ideas on Railroading

Would Reduce Weight of Equipment, Expedite Car Movement, Remove Lawyers and Simplify Accounting

HENRY FORD, in an article in the Nation's Business, *gives his views on how to run a railroad, illustrating some of his points by telling what has been done with the Detroit, Toledo & Ironton, which he acquired last year. He would get the ownership into the hands of those who operate it, cut down the weight of equipment, speed up the moving of cars, reduce the legal force and simplify the accounting. Says Mr. Ford, in part:*

The real purpose of a railroad is to serve the public. There is no reason why it should be diverted from that service and set to doing an entirely different thing—putting money into the pockets of stockholders who make no contribution to the road's actual operation. . . . There is a possible and practicable system of financing railroads by which those contributing the money will be in positions to aid directly in the success of the undertaking. If the brakeman on a railroad owns stock in it, he has an additional inducement to competent service. Better service is a valuable by-product which will come from his ownership of stock. If the railroad is a success, it is due to him and his fellow-workmen, and they are entitled to the profit.

Railroads should not have to go to banks for money. Make it possible for people to use the railroad as much as they want to. Then there will be no trouble about finances. The trouble is that we start with finance and expect finance to make the road go.

Proper financing would, of course, be easier on new roads. On the old ones, however, it should be possible to retire the parasite, the non-contributing stockholder and get the ownership into the proper hands.

After removing this dividend drain, the second step would be to remove the great physical burden of the railroads—needless weight of its rolling stock. Overweight of rolling stock is the prime mistake on the mechanical side of railroading. Engines and cars are four or five times as heavy as they should be. On the Detroit, Toledo & Ironton we are using up the old types of engine and car, but they will be displaced by better types.

The third step, an immediate step which should be taken in the operation of any great railroad system would be that of expediting the journey of the freight carrier. On the Detroit, Toledo & Ironton we tolerate no idle men, idle cars or idle engines. Loaded cars or trains on side tracks are proof of inefficient operation. They can be made to keep moving. . . .

Our experience illustrates this [the waste of shippers' money due to slow delivery] excellently. The road we have acquired runs north and south and crosses most of the transcontinental lines. By speeding up our freight on this preliminary part of its journey we have been able to shorten the time of its delivery by periods ranging from 7 to 14 days. This means that our product gets to the people to whom we sell it from 7 to 14 days quicker than it used to. It means that we carry on our books $30,000,000 less undelivered product than we otherwise would.

Most railroads have enough lawyers working for them to operate them if they were engaged in useful work. One of the first things is to dispense with the legal staff. A well-managed road needs less of that sort of service. We did just this on the Detroit, Toledo & Ironton. The lawyers are mostly in the claims department. Any small claim against a railroad is very likely to knock about the claims department for weeks or months, to require endless clerical attention, to clog the machine, to cost many times as much as it would to pay it. Proper organization would lead, at the time it is first presented, to establishing the facts about it and settling it on the basis of justice. It would keep all this detail off the books. Few claimants would refuse to settle on the basis of the facts.

The bookkeeping of railroads is complicated far beyond all necessity. The amount of unnecessary work you can find in the accounting system of even a little railroad, the amount of duplication and red tape, is almost beyond belief. We have simplified this department, reduced its cost, and have transformed it into an actual help to the railroad instead of a vexation and a burden. How did we do it? By viewing the whole proposition as a service to the users of railroads and making everything fit into that, instead of having the fear of stockholders and dividends before our eyes. Our faith is that service will pay. Finance does not come first. Work comes first.

We don't claim to have done anything new in railroading—yet. We have only taken the old system of operation and cut off its obvious absurdities. Even the old system of railroading, brought up to efficiency, would be an immense change for this country. We have simply cut out the loafing of men, the loafing of engines and the loafing of cars. The result seems to have surprised many people. But there is no mystery or magic about it. Anyone can do it. If the introduction of plain, everyday good management will create such a change, what may we not expect from really new ideas?

Cape May Hangar for Dirigible Built From Two Small Ones

Sheds at Montauk and Cape May Re-erected on New Base Sections To Produce Hangar of Greater Capacity

WITH the completion of the new hangar for giant dirigibles at Cape May, New Jersey now has two sheds capable of accommodating the largest aërial conveyances yet built. The Cape May hangar, while considerably smaller than the great Lakehurst structure (described in *Engineering News-Record*, May 6, 1920, p. 892) is similar to it in type but differs in one interesting respect, namely, in having been constructed by piecing together two smaller hangars, at the same time raising them 40 ft. by setting them up on new base sections. This unusual reconstruction was carried out by the Associated Contractors, of New York, and the

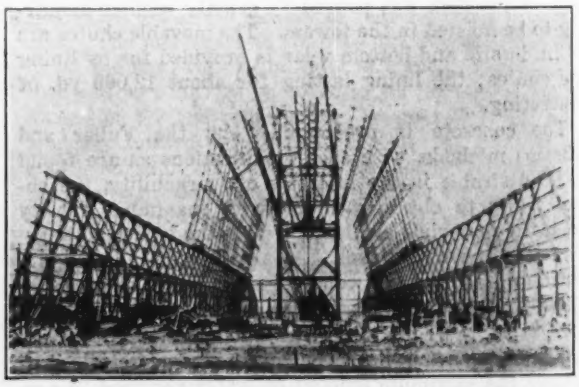


FIG. 1. NEW CAPE MAY HANGAR DURING ERECTION

Bethlehem Steel Bridge Corporation, which latter erected the steel frame.

The completed new hangar is 156 ft. wide, 710 ft. long, and 110 ft. high in the clear at the door; the clear width of the door opening is 106 ft. A lean-to 16 x 122 ft. extends across the end opposite the door. The original smaller hangars, which were identical, were located at Montauk, N. Y., and Cape May, N. J., respectively. Each was 250 ft. long, and had a framework of

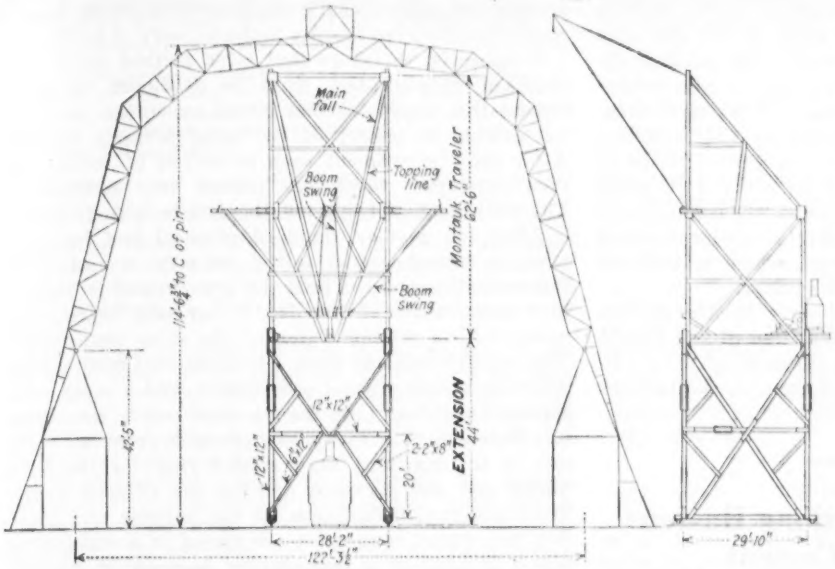


FIG. 2. FRAMEWORK OF OLD HANGAR AT CAPE MAY

three-hinged steel arches of 122 ft. span, spaced 20 ft. 10 in. apart center to center. In the new structure these arches are set on steel base frames 41 ft. high, making the height of the new structure 113 ft. 6 in. from floor to crown pin; and an additional amount of framework for a 210-ft. length of structure was provided.

In taking down the Montauk hangar a wooden tower traveler 28 ft. square by 64 ft. high, with two 55-ft. wooden booms seated halfway up the tower, was used to handle the steel. Both booms were operated by one steam hoisting engine. The half arches, weighing 6 tons, were handled each by one of the booms. Only the last arch had to be guyed temporarily. The traveler moved forward on a track on the concrete floor as the dismantling progressed. The steel members were match-marked before removal to facilitate re-erection. The traveler was then re-erected at Cape May, but was increased in height 44 ft. by a bottom extension, to take care of the greater height of the new hangar; the hoisting engine remained in its old location on the lower cross-framing of the original traveler, now 46 ft. above ground. Both the dismantling of the old Cape May hangar and the erection of the new one were handled by the traveler thus raised.

Erection of the new structure was greatly facilitated by the use of a 30-ton locomotive crane as assistant to the traveler. The 70-ft. boom of the crane, fitted with a 20-ft. extension, served to hold up arch sections while the traveler booms erected adjoining sections, drove pins, and filled in between the arches. The 55-ft. traveler booms were extended by 20 ft. for this latter work.

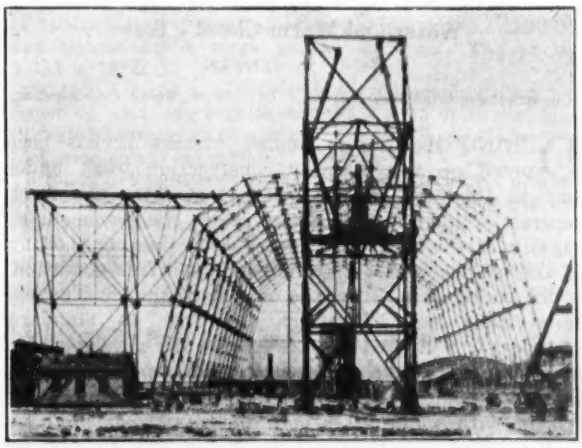


FIG. 4. ERECTION TOWER

The old hangars contained each about 350 tons of steel, of which 284 tons in one case and 238 tons in the other were used in the new structure.

The hangar was designed to be part bolted, but as the work was carried out all field connections were riveted.

Each of the three-column base bents rests on a reinforced-concrete girder foundation, carried on clusters of wood piles. The mastic floor of the hangar contains two box-shaped docking rails, 90 ft. apart, extending through the whole length of the hangar and 1,000 ft. beyond into the landing field. Within these rails operate the trolleys to which the airship is attached for landing and entering.

The sides of the building were sheathed with wood covered with asbestos shingles, while the two sliding doors, which in construction are substantially identical with the doors used at Lakehurst, are covered with cor-

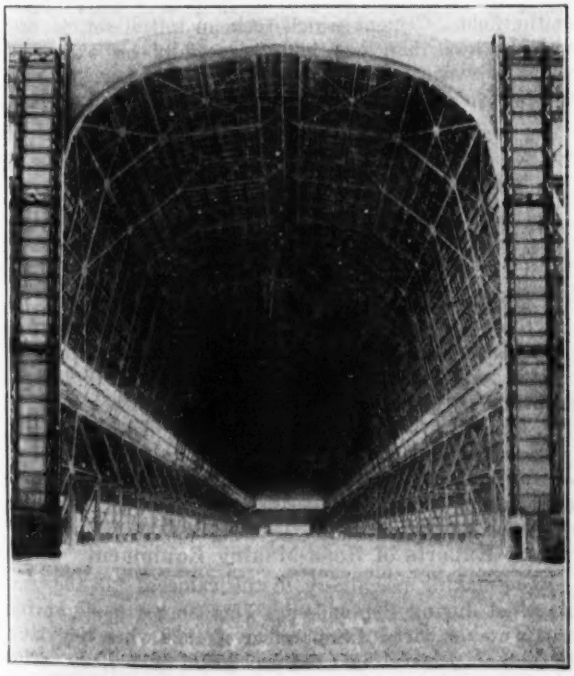


FIG. 3. THE COMPLETED HANGAR FROM THE ENTRANCE

rugated asbestos. In the construction of the packing or cushion strip at the meeting edges of the doors an essential change was made, however. The original design called for this strip to be a sheet of ¼-in. rubber cloth, its edges bolted to the flanges of the steel channel forming the edge of the door, and its middle portion held out to a semi-circular contour by curved strips of No. 16 gage spring steel 4 in. wide, every 3 ft. along the length of the door edge. As built, the cushion consists of pure rubber sheets backed by a continuous strip of wood of segmental cross-section, which is held out from the door channel by spiral springs.

The hangar was built for the navy by the Bureau of Yards and Docks, and under direction of the Fourth Naval District, League Island, Rear-Admiral F. R. Harris, public works officer. Lt.-Com. J. N. Laycock was in field charge.

Atmospheric Conditions Hasten Initial Set of Cement

Standard Physical Test Fails To Detect Sub-normal Initial Setting Time Disclosed by "Hot Water and Warm Closet" Test

By C. L. Jenken

Construction Engineer, Maricopa County Highway Commission, Phoenix, Ariz.

During the warm summer months it has been noted on the highway construction work under way in Maricopa County, Ariz., that often the fresh concrete would take its initial set in the pavement so rapidly that within 30 minutes after mixing, belting of the surface was almost impossible. This condition, which occurred with the use of cement that had passed tests made most carefully according to standard methods, was studied until a means was developed for detecting cement having such characteristics. This is now accomplished by mixing the test samples of cement with water after both water and cement have been warmed to a temperature of 100 deg. F., and, in order to approximate in the laboratory the conditions that obtain in the field, keeping the samples at this same temperature in a damp closet until the initial set has taken place.

After a series of tests made on the job and in the laboratories of the cement manufacturers in California, and checked by other laboratories, it was conclusively shown that cements would take their initial set in one to two hours less time in Phoenix than in Southern California. This difference was believed to be due to the arid climatic conditions in Phoenix, which is noted for the low atmospheric humidity and high temperatures between June 15 and Sept. 10. The accompanying table giving data of two winter months, and two summer months shows the extraordinary dryness and other climatic characteristics of the locality where the Maricopa County highway work is under way.

TYPICAL CLIMATIC CONDITIONS, PHOENIX, ARIZONA

	Mean Temp., Degrees F.		Precipitation, Inches	Evaporation, Inches	Wind — Movement, Total, Miles	Wind — Average Hourly Velocity	Relative Humidity, per Cent — Morning Observ.	Relative Humidity, per Cent — Evening Observ.
	Max.	Min.						
January...	66.5	37.5	0.13	3.069	3,315	4.5	67	35
February..	73.3	42.0	0.11	5.122	3,639	5.4	58	24
June.....	101.4	68.2	0.04	12.822	3,761	5.2	34	14
July.....	101.3	77.1	0.38	12.081	4,634	6.2	59	32

It appeared therefore that some method other than standard physical test must be developed to detect cement that would take its initial set in the pavement too quickly to permit of its being properly handled. After some experiment such a method of testing has been developed, which has proved very satisfactory. The method of carrying out these tests is as follows.

After the regular standard physical test has been made, a second test of initial set only is made from the cement sample. First, the dry cement is warmed to a temperature of 100 deg. F., or very nearly, then mixed with a mixing water of the same temperature. This usually required from 1 to 3 per cent more mixing water to obtain normal consistency, and a much more vigorous kneading than the standard test to thoroughly mix the paste. Two test pieces are made from this paste, one in the standard hard rubber ring for the Vicat needle and one standard pat for the Gilmore needle. These are run in duplicate for the purpose of a check. The test pieces thus made are stored in a moist closet which is kept at a temperature between 90 and 100 deg. F. until the initial set takes place.

The accompanying table showing the result of initial set tests under different temperatures, clearly shows the effect of temperature. Tests A, B and C were made from the same sample of cement. Test A being the result of the standard test, which gave an initial set of 2 hours and 1 minute. Test B was made under a higher temperature and in this case set in less time than the standard test. This temperature, however, does not consistently cause set in less time and is not dependable. Test C was made in accordance with the above described method and in this particular case set in 49 minutes. This same cement was observed in the field while being placed in the pavement and was found to set in about the same length of time. About 1 hour for the initial set under this method was found to be about the minimum length of time to work properly in the field. Cement which took an initial set, in this test, in less than one hour, especially on extremely warm or warm and windy days, invariably set too soon to allow the proper belting of the finished road surface.

Test	Laboratory Atmos. Temp., Deg. F.	Dry Cement Temp., Deg. F.	Mixing Water Temp., Deg. F.	Normal Consistency, per Cent	Initial Set — Vicat	Initial Set — Gilmore	Initial Set — 24 Hr. Pat. 5 Hr. in Steam	Moist Closet Temp., Deg. F.
A	76	78	78	23¼	1 hr. 26 min.	2 hr. 1 min.	O. K.	76
B	96	80	78	24	1 hr. 6 min.	1 hr. 47 min.	O. K.	80
C	96	100	100	26	31 min.	49 min.	Slightly soft	96

This seems to prove conclusively the contention previously made that the extreme dryness and high temperature is responsible for this peculiar behavior of the cement. With the aid of the manufacturers' co-operation and through their effort to furnish a slow setting cement this difficulty has been almost entirely eliminated.

Exports of Road-Making Equipment

Road-making machinery to the value of $73,108 was exported during September. This shows a slight increase over exports of September of 1920 when the value of such machinery exported was given as $67,169. The figures are those of the Department of Commerce.

LETTERS TO THE EDITOR

This department aims to be a forum for the discussion of the views of engineers and contractors. The range of interest should be as wide as possible. Contributors are, therefore, asked to make their letters short.

Ills of Excessive Mechanization

Sir—That excessive mechanization of industry has denied many workers the true significance and physical benefit of of labor is the opinion of Mr. Beck and forms the subject of recent editorials in *Engineering News-Record* and other journals.

This opinion presents a problem as to whether or not engineers should design industries with a view of using automatic machinery, and of accomplishing a given task with a minimum number of motions. The correct solution of this problem depends upon the comprehension of the fundamental nature of man.

A number of late thinkers have proposed the doctrine that man is fundamentally a "time-binder," (this term is used by Alfred Korzybski, on "Manhood of Humanity"), that he differs from vegetables and animals in that he begins where his predecessors left off. Ants build their hills in precisely the same manner forever; men develop their race. Man grows two blades of grass where one grew before, and this is possible because man can integrate all the accomplishments of his predecessors into a desired end.

With this view of man we need apprehend no fear of man becoming a mere machine tender. Machines should be made which require a minimum amount of tending. There is inspiring work enough for all. Just as a workman in James Watt's day was congratulated if he made a cylinder only three-eighths of an inch out of true, today he is congratulated if he makes a cylinder only three-ten-thousandths of an inch out of true.

WILBERT BERNHARDT,
South Bend, Ind., Sept. 24. Hydraulic Engineer.

Design of the Birkenhead Covered Reservoir

Sir—I am greatly interested in the 40,000,000-U. S. gal. covered service reservoir for Birkenhead, England, which, in your issue of Sept. 29, p. 535, you describe as an "amazing structure," and "a curious structural layout." But why so designate it? When all the facts are understood the design will be seen to have followed rational principles.

As I was associated with the engineer of the reservoir, the late Dr. Deacon, and his successors, Sir Alex Binnie, Son & Deacon, from its inception in 1906 to the completion of the contract drawings in 1912, a word from me on the basis of design will not be out of place. The construction, I understand, was held up due to the Great War. In the design of this reservoir it was decided not to follow the precedents of reservoir design to any great extent but to start afresh on sound principles and follow them to their ultimate and proper conclusions; that is to say, it was to be designed, not copied from earlier, less important examples. It was felt that such an important work should possess character, should be economical in design and should properly fulfil the purpose for which it was to be constructed in that, among other things, it should be entirely free from leakage, and these requirements have been met entirely. The reservoir is constructed on a site where underneath the surface deposits of a variable character lie open jointed porous sandstones into which any leakage would find its way. Puddled clay could not be economically secured and as all concrete linings of service reservoirs leak more or less it was decided to use bitumen in bulk since the water-tight layer throughout and most of the peculiarities of this reservoir are due to this material placed as a vertical layer within the body of the walls—it being supported on the inside by brickwork in the form of horizontal arches with counterforts at intervals stiffened by the vertically placed steel beams and on the outside by concrete backed with earth. The inside lining of vitrified brickwork was adopted owing to its superiority to concrete and as it could be constructed without forms. The principal use of the so-called reinforcing at the groins of the roof is not structural; it served a useful purpose during construction in preventing displacement of the tops of the high columns.

The decision to use a cover of domes laid out on a hexagonal plan arose from the fundamental fact that domes of concrete can be more easily supported on a hexagon at six points than on a square at four points; or, in other words, a hexagonal roof plan required a less number of columns to support it than a square plan with the same condition of loading. As the number of columns affect the cost and column points in the floor are invariably points of distress and leakage, requiring special attention, the less their number the better. In this feature there was probably also the element of boldness, character and freedom, the absence of which makes many engineering structures drab and commonplace.

WILLIAM GORE,
Toronto, Ont. Consulting Civil Engineer.

Long-Lived Pine Stakes

Sir—In your issue of Sept. 29, page 530, is a short article on life of redwood stakes in California, some of the stakes being in good condition after standing forty-seven years. I can go you one better.

In 1835 the City of Pensacola, Fla., attempted to build a railroad northward toward Montgomery, Ala. Some ten or twelve miles of roadbed were graded and the right-of-way cleared for a much greater distance. The project failed in 1837.

In 1908 I made a survey over the old grade, which had grown up with long leaf pines from 6 to 15 in. in diameter. I counted as many as 67 annular rings on some of the trees that were cut by my axmen.

I found five lightwood knot fat pine stakes of the original survey, two on the center line and three on the slopes. In size they were about 2 x 3 x 36 in. All of the stakes were sound, and seemed to be in as good condition as when placed, over seventy years before.

J. M. GARRETT,
Montgomery, Ala. Civil Engineer.

To Prevent Sand-Drifts on Roads

Sir—The note on how Fresno scrapers were used to keep sand-drifts off plank roads in Imperial County, Cal., (*Engineering News-Record*, Sept. 29, p. 518) suggests the possibility of combating these sand-drifts with a beach-grass called "helm" celebrated in Holland, which has done and still does effective work over there. This material planted along California highways would go a long way toward eliminating sand-drifts. This beach-grass or "helm" spreads its rough roots, with numerous long lateral sprouts, close to the surface and to a distance of 20 ft. This grass is coarse, yellow and greenish in color and grows to a height of 3 ft. Its use would undoubtedly save Imperial County great sums of money.

The California Highway Commission should build on its road berms vertical mats 3 ft. high, woven from local material such as two-year-old willow shoots or water reed, placed at a distance of 100 ft. apart. These mats have to be stiffened by stakes at 3 ft. distances, thoroughly tied into the mats with good twine or galvanized wire. The stakes, 3 in. in diameter, should be solidly driven into the berm.

If the winds blow most of the year from one direction the mats must be on the side from which the winds blow and bear against the stakes. When placed on the berm at right angles to the road or on a slight angle, the mats accomplish about the same work as groins do in protecting the river shore line against scour. They catch the suspended silt, which deposits, causing the shore line to advance and raise itself.

The roads should be at an elevation higher than the surrounding level to prevent sand or snow from settling on the surface. If the Imperial County roads happen to

be in a cut with wide berms, there is no reason to postpone the mat work.

If the planting of helm is to be done on slopes, they must not be too steep, preferably a slope of 1½ to 1 or if possible of 2 to 1 in order to give the beach-grass a fair chance to grip the sand soil.

C. KOOY.

New York City, Oct. 8,

Actual Traffic Loads on Bridges: Ohio River Bridge at Ironton

SIR—I read with interest the article in your issue of Oct. 13 descriptive of the bridge now being built across the Ohio River between Ironton, O. and Russell, Ky. There has been need for a bridge at this place for a long time, and it is a credit to those who successfully raised, by popular subscription, money enough to completely finish the structure without an issue of bonds or other indebtedness.

There is some doubt in my mind as to the live-loads assumed for the determination of stresses. The article states that live-load stresses were computed for two electric cars, each weighing 45 tons, and 30 tons on the remaining 16 ft. width, distributed over a length of roadway and sidewalk of 90 ft., and a road roller weighing 18 tons applied at any point. It is probably true that stresses due to the road roller have been used in designing only those members in which the stresses due to it exceed those caused by other live-loads. The other live-loads specified amount to 120 tons on a unit length of 90 ft. This question arises: Were the stresses determined from the passage of a single 90-ft. length of load across the bridge, or were they determined from a continuous series of 90-ft. loaded lengths? The statement in the article mentioned indicates that the stresses were determined from the application of a single unit of length, or a total live-load of 120 tons, distributed over a length of 90 ft. and applied in various positions successively.

If it is assumed that the facts are as just indicated, it is found that the total live-load, when applied to the anchor arm, amounts to 686 lb. per lin.ft., when applied to the suspended span it amounts to 640 lb. per lin.ft., when applied to the channel span it amounts to 331 lb. per lin.ft., and when applied to the 200-ft. approach span it amounts to 1200 lb. per lin.ft.

A continuous line of loaded street cars, such as are in service in cities, will weigh about 1400 lb. per lin.ft. Suburban cars are somewhat heavier. From actual observation it has been found that the weight of a continuous line of automobiles and power-driven trucks is about 500 lb. per lin.ft. and of a mixed line of street cars, automobiles and trucks about 800 lb. per lin.ft. It therefore appears that a possible live-load may be:

	Lb. per lin.ft.
One line of street cars	1400
One line of automobiles and trucks	500
One line of sidewalk at 50 lb. per sq.ft.	300
Total	2200

It is however, probable that there will never be a continuous line of street cars on the bridge and that automobile trucks will not all be fully loaded so it is probable that the maximum load per foot that the bridge may be required to carry will not exceed:

	Lb. per lin.ft.
For a mixed line of street cars, automobiles and trucks	800
One line of automobiles and trucks, not all fully loaded	400
One line of sidewalk	300
Total	1500

A load like this might occur on any occasion that would attract crowds onto the bridge, as is possible in connection with an opening celebration. This load is 4½ times that for which the main channel span has apparently been designed. Even the wind load in the plane of the floor is greater than the load apparently assumed for the channel span.

It is to be hoped that the statement in regard to the live loads used in computing the stresses is in error, otherwise, I believe the facts in the cast should be brought to the attention of the proper parties in order that there may be a thorough understanding and that such steps as seem desirable may be taken to safeguard the public.

Pittsburgh, Oct. 21. CHARLES S. DAVIS, Consulting Engineer.

Making Water Meters Misdemeanors: A Rejoinder

SIR—Referring to the edtiorial note in your issue of Sept. 29, "Making Water Meters Misdemeanors," I think you are the body "having so little information and judgment." Have you not concluded that what may be good and necessary for a large city in the East is good for Stockton?

Have you duly considered the fact that Stockton is nearly all small residences and is located in an arid region having 8 to 10 in. of average yearly rainfall with maximum daily temperatures during the summer of from 100 to 110 deg. F., combined with air of a very low relative humidity; and that as a consequence of his, without liberal sprinkling, lawns and flowerbeds would disappear in less than a week, to the great detriment of the people. That the dead grass, etc., does constitute a serious fire hazard can hardly be denied.

Here in Fresno, thanks to a progressive water superintendent who thoroughly understands the situation, we have a flat monthly rate estimated for each residence. For an average five or six-room bungalow on a lot of say 50 x 150 ft., this rate is $1.75 during the summer and $1 in the winter for all the water needed. There is, no doubt, some waste of water, but not anything like enough to pay for meters.

If you could compare the appearance of Fresno with Berkeley, where vegetation needs far less water, but where water meters would run the price of properly watering the average small bungalow lawns and gardens up to $6 or $8, to say nothing of the necessity of spending an additional $4 for drinking water, as was the case a couple of years ago, as the water was unfit for drinking purposes, although no doubt absolutely safe, you would get a far better understanding of the question you are discussing. This is not the fault of the water meter, to be sure, but its effect. Let us not forget that when a property owner keeps his lawns and flowers green and pretty it is worth something to everyone who sees this, and with water meters and the consequent much higher rates he could probably not afford to do this.

I do not believe you can mention a single city or town with water meters where water is as abundant, as good, and as cheap as here in Fresno.

B. F. JAKOBSEN.

Fresno, Cal., Oct. 7.

[The water meter prevents wanton waste and where such is persisted in makes the wasters foot the bills instead of putting the burden on the careful consumer. If the meter rates, including minimum charges, are properly framed there will be no reason for letting lawns dry up to keep down water bills. Moreover, the provisions of the Stockton ordinance which we condemned were sweeping in making the installation of any water meter a misdemeanor, regardless of whether the water were to be used for irrigation or some other purpose. Such legislation is like using a bludgeon instead of brains.—EDITOR.]

Labor Supply and Demand

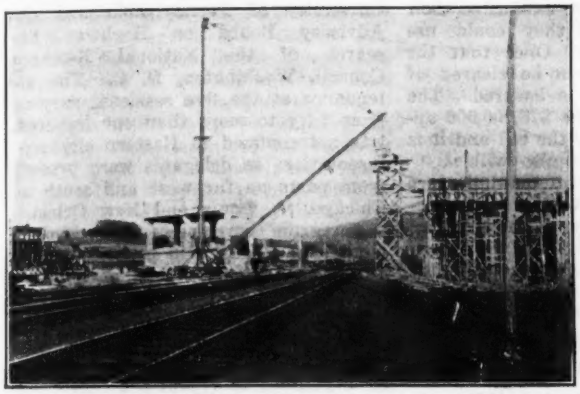
Reports from the Division of Employment of New York State, covering operations of employment offices in six cities, show that the ratio of workers applying for work to each 100 places available was 125 in July. This indicates an improvement over the employment situation of the preceding month, when the ratio reported was 139. Reduction in unemployment from June to July was largely due to a temporary absorption of some of the unemployed into the agricultural industry for harvest work.

HINTS FOR THE CONTRACTOR

Concrete Gang Reduced Through Intensive Use of Mechanical Equipment

BY H. W. YONTS
Ravenna, Ohio

IN THE construction of a reinforced-concrete bridge, 148 ft. long with a 24-ft. roadway, consisting of two approach spans and a steel girder concrete-incased span over the Philadelphia & Reading Ry. at Malino, Pa., the contractor so arranged his mechanical plant that he was able to operate successfully and without expensive shut-downs with an average crew of eight men. The bridge was built in order to provide an overhead crossing for the highway from Hamburg to Pottsville, Pa., and was constructed during 1920, when there was a



ARRANGEMENT OF MECHANICAL PLANT

labor shortage and the contractor was forced to resort to intensive use of mechanical equipment.

The plant consisted of a 10-ton derrick with an 85-ft. boom and an 82-ft. mast, equipped with a 1½-yd. clamshell, which unloaded and stored all the sand and crushed stone needed for the work; and a large bin holding 65 cu.yd. of stone and 35 cu.yd. of sand, with the concrete mixer located in front of the bin and fed by gravity from it. The bin was filled each morning, the filling occupying about 2 hr., and the derrick was used to handle the concrete from the mixer to the forms. The bin held enough material for a run of 7 hr., or 65 cu.yd. of concrete. The mixing crew consisted of one hoisting engineer, one mixer runner, one bin man, one man at the forms to dump the derrick bucket, two men spading concrete and placing reinforcing steel, and one foreman. When this crew was not concreting, it assisted the carpenters in building the forms.

A 10-cu.ft. gasoline-driven mixer was used with a power loader which slid under the bin and was loaded with the proper amount of sand, stone, and cement. The cement was unloaded from the cars by a chute to a portable cement house and the mixing plant was located at the door of the cement house so that the cement did not have to be raised by laborers. With the use of the large derrick it was possible to store all materials as they arrived and expensive shutdowns due to waiting for materials were eliminated. The contractor eliminated 80 per cent of labor trouble in mechanically handling all aggregate.

The work was done under the direct charge of Edward Gorman, division engineer, Philadelphia & Reading Ry., assisted by D. F. Duffy, inspector. The contractor was Thomas Sheahan, Hagerstown, Md., with H. W. Yonts as superintendent.

Clean Concrete With Burning Gasoline

GASOLINE poured over asphalt joints between concrete slabs or on concrete surfaces and then ignited constitutes a method of cleaning the surface that is quick, inexpensive and does not damage the concrete, according to the Waterproof Paint Co. of Lankershim, Cal., from which the following notes were obtained. Using tools to remove the asphalt from a narrow joint often breaks out the side walls in an unsightly way and is a slow process.

A convenient way of removing the coating is to use a small oil can filled with gasoline. Several applications may be required to entirely remove all the old asphalt compound, the operator walking along the joints, each time leaving a trail of gasoline which is then ignited. It is better to use a small quantity of gasoline and repeat the process, rather than to use a larger volume which might be dangerous in inexperienced hands.

Where the method is used in concrete reservoirs covered with wooden roofs, care should be exercised to see that adequate ventilation is provided before the gasoline is used. The picture shows several tons of asphalt being moved from a reservoir surface by this method which left the surface perfectly clean. On this job one man removed a ½-in. asphalt coating from an area of 15,000 sq.ft. in two days. As a safeguard in avoiding damage to the concrete when treating large

BURNING ASPHALT FROM CONCRETE RESERVOIR

areas, a continuous fire should be avoided. The work can be done in sections, starting fires with small quantities of gasoline and returning later to reburn where necessary. Working in this manner one man can ordinarily clear the surface quicker than a dozen laborers employed in scraping off the compound.

NEWS OF THE WEEK

New York, October 27, 1921

Favor Narrows Tunnel and New York Belt Railway

Engineering Committee from Board of Estimate Recommends Staten Island Project

In a preliminary report just rendered to the Board of Estimate Apportionment, New York City, by an engineering committee headed by Arthur S. Tuttle, chief engineer of the board, to study the project for a Narrows freight tunnel which the state legislature recently directed the board to construct, the committee strongly recommends that such a tunnel be built It states, however, that the tunnel will be inexpedient unless it is connected with all the railways serving the city so as to provide direct rail interchange between railways and industries, between the metropolitan districts of New Jersey, Long Island and Manhattan and the mainland on the east side of the Harlem, and between freight cars and ships. To this end the committee recommends that as part of the tunnel project a great outer belt line be constructed around the city, extending from Haworth, N. J., west and south through Glen Rock, Paterson, the upper Passaic Valley, Summit and Scotch Plains to a high level crossing of Arthur Kill at the southwestern part of Staten Island, and thence via a huge classification yard northerly to the Narrows tunnel; and that on Long Island the tunnel be connected with the Long Island R. R., the New York Connecting R.R., and an industrial waterfront elevated railway to be built in Brooklyn.

Follows Wilgus Report

In its main course the belt line follows a route recommended some years ago by William J. Wilgus and a similar route surveyed later by J. B. Snow. The former is now consulting engineer and the latter tunnel engineer to the committee. Separate reports from these two engineers and J. F. Sullivan, another consulting engineer to the committee, accompany the main report. Mr. Wilgus and Mr. Snow differ on the preferable location of the Narrows tunnel and the type of construction, the former favoring a northerly route and the construction by the trench method, while the latter favors a southerly route and shield construction. Mr. Sullivan concurs in Mr. Wilgus' recommendations. In a separate report by Mr. Sullivan, a tunnel connection from the New York Central freight tracks along the Hudson River in upper Manhattan to the railway lines in the eastern part of Bronx borough is recommended; this would pass under 168th St., crossing under the Harlem River, to the line of the New York Connecting R. R. Mr. Wilgus concurs in this recommendation.

An investment of $141,000,000 will be required to carry out the project. Of this total, $42,000,000 is for the belt line, $51,000,000 for the freight and passenger tunnel under the Narrows (including separate rapid-transit connection from Staten Island to the Fourth Ave. subway in Brooklyn), $25,000,000 for the Brooklyn industrial elevated railway, and $23,000,000 for the Manhattan-Bronx tunnel. The system would return a profit of $5,000,000 per year over and above operating and fixed charges, the committee estimates.

Expect Early Vote on Conference Report of Highway Bill

(Washington Correspondence)

Since the conferees completed their work, the fight for federal aid highway legislation has been behind the scenes. The fact that no word concerning this bill has been uttered in the meantime, in either hall of Congress, was no indication that the opposition had quit and the fight was over. The opponents of this measure have fought to the last ditch, but as this is written, it seems practically certain that the House will vote on the conference report before the end of the week. The opponents of the measure evidently have exhausted their last resource which they could use against the measure. Once that the parliamentary way can be cleared of obstacles, the result is assured. The House will approve the $75,000,000 appropriation carried by the bill and it is believed the President also will.

That the enemies of the bill were waging a good fight with their parliamentary weapons may be judged from the fact that the weight of Secretary Hoover's influence was made use of by the proponents of the legislation.

Lack of Funds May Slow Up River and Harbor Work

(Washington Correspondence)

An understanding is said to have been reached on Capitol Hill to the effect that a very small amount is to be carried in the next river and harbor bill. Practically all of the accumulated surpluses of river and harbor funds will have been expended by the end of the present fiscal year. These surpluses accumulated during 1919 and 1920 when the work was held up by the high price of materials. Since only $12,400,000 was carried in the last river and harbor bill practically all of the accumulated surpluses will have been expended by the end of the current fiscal year.

Paving Conference Opposes Long-Term Guarantees

Philadelphia Meeting Discusses Recent Developments and Recommended Changes in Paving Practice

Almost unanimous opposition to the current practice of demanding from contractors long-term guarantees on paving construction was expressed at the City Paving Conference held Oct. 20-21 in Philadelphia, under the auspices of the Engineers' Club of that city, with the co-operation of the municipal highway bureaus of Philadelphia, Baltimore and New York, the University of Pennsylvania and the Advisory Board on Highway Research of the National Research Council, Washington, D. C. The attendance at the five sessions, varying from fifty to more than one hundred, was not confined to Eastern city representation, as delegates were present from parts as far west and south as Chicago, St. Louis and New Orleans. A program covering recent developments and changes in practice in the design and construction of all the standard paving types in addition to such subjects as research, sub-structures, inspection and guarantees, was completed in a business-like manner. It is planned to repeat the conference next fall, at which time a summary of answers to a questionnaire on paving methods, which is to be sent to all cities having a population of 10,000 or more, will be presented.

Asphaltic Filler Favored

In the consideration of details of paving practice a marked sentiment favoring the use of asphaltic filler for both brick and granite block developed, following papers by P. C. Painter, city engineer of Greensboro, N. C., and C. D. Pollock, consulting engineer, New York. It was also emphasized, in the case of brick paving, that with a bituminous filler a thin sand cushion, from ½ to 1 in. thick, is preferable to a cement-sand bed, on grounds of both service and economy. Mr. Pollock was insistent on the need of thorough hand ramming for granite blocks and decried the substitution of road rollers for this operation.

In wood block practice, according to a paper by Ellis R. Dutton, of Minneapolis, there have been no recent developments; for best results it is desirable, he said, to have a smooth concrete base, uniform length of block, a thin bituminous cushion and a bituminous filler so applied as to leave no excess of filler material on the top surface of the block. The discussion brought out the

fact that so little wear from abrasion by traffic had been observed in the case of wood block paving that blocks thinner than those ordinarily used could be employed to advantage. Two Pennsylvania cities, Lebanon and Tyrone, have laid wood block only 2½ in. thick.

Asphalt paving methods and materials were considered in papers by Major F. S. Besson, Corps of Engineers, Washington, D. C., Julius Adler, Bureau of Highways, Philadelphia, J. S. Miller, chief chemist, Barber Asphalt Paving Co., and Dr. Felix Kleeberg, Department of Public Works, Manhattan, New York. Major Besson described methods developed by him for proportioning asphaltic surface mixtures to prevent shoving and cracking. Defects in asphalt paving, according to C. M. Pinckney, Bureau of Highways, Manhattan, New York, are often due to lack of thorough mixing of the material at the plant. The probable extension of motor bus service in New York and other cities, he pointed out, justifies more care in the design and construction of asphalt surfaces than ever before, to withstand the heavy loadings which will be imposed on streets. Displacement of surfacing by heavy traffic is Philadelphia's chief problem in asphalt paving maintenance, according to Mr. Adler, who urged quality as against mere quantity production in this line of work.

Against Guarantees

Prof. S. A. Stephenson, Jr., of Rutgers College, New Brunswick, N. J., with his paper on guarantees and inspection of paving, precipitated the keenest discussion of the conference. The guarantee, he held, should be limited to cover the faithful performance of the requirements of the contract and specifications, and should not be camouflaged as a long-term maintenance fund. This view found wide support among the highway engineers present, and it was noted that the Pennsylvania State Highway Department recently eliminated the guarantee from its contracts and now depends on rigid inspection and co-operation with the contractor to secure good results. New York City, Mr. Pinckney announced, is considering the reduction of the term of its paving guarantees to one year. W. H. Connell, formerly chief of the Philadelphia highway bureau, stated that a guarantee may sometimes be desirable in cases where an engineer, due to the injection of politics in highway administration, is deprived of complete control over his organization.

Both R. A. MacGregor, Department of Public Works, Manhattan, New York, and Col. R. Keith Compton, of Baltimore (through a representative of the City Paving Bureau) urged the adoption of policies preventing the cutting of newly laid paving for repair or extension of sub-surface structures, such as gas or water mains, electric light conduits and sewers. Advance notices to public utility corporations, individual property owners and other city departments of intention to pave should be sent out and warning given to have all extensions and repairs on underground structures completed before the pavement work starts.

Mr. Pinckney's papers on factors determining the selection of pavement types brought out discussion on the advisability of limiting vehicular loads on city streets. Flint, Mich., according to Ezra Shoecraft, has found it necessary, on account of increased traffic, to thicken all new pavement foundations to 8 in., as against 6 in. formerly adopted. Until highway engineers have control over the loads which pavements will carry, Mr. Pinckney pointed out, types of construction cannot be intelligently selected.

Research

The conference opened with a paper by A. T. Goldbeck, engineer of tests, U. S. Bureau of Public Roads, in which it was pointed out that paving design, because of the extreme loads which vehicular traffic of today imposes, has become a problem in mechanics. Mr. Goldbeck reviewed the research work in the fields of drainage, soil investigation, impact and wearing qualities of surface which the Federal Government is now conducting. Much of the discussion dealt with the influence of moisture in reducing the supporting power of sub-grade material. Plastic clays are particularly troublesome and tests thus far carried out indicate possibilities in the mixture of dry cement with the clay to change its properties. It remains for the future to disclose, according to Mr. Goldbeck, whether such methods of subgrade treatment will prove economical or not. Prof. W. K. Hatt outlined the work which the Advisory Board on Highway Research, of the National Research Council, is doing. He pointed out that there are now completed or under construction six experimental concrete roads, tests of which are expected to yield data of great value in the design of such types.

In his paper on repair and maintenance problems, P. C. Sharples, of the Barrett Co., urged that more attention be given to the lower types of roads and described repair methods by cold patching. J. C. Grinnalds, of Baltimore, showed how the selection of paving types is facilitated by city planning.

Power Development Right Granted Northern Ontario Railway

The Ontario government has granted the Timiskaming & Northern Ontario Ry. Commission the right to develop power in the vicinity of the Big Bend on the Abitibi River north of Cochrane. It is understood that the commission proposes to utilize the power which is variously estimated at from 15,000 to 30,000 hp. for the electrification of the road, or a section of it, and surplus to be sold to mining companies or other consumers.

One-Fourth of Railway Operatives Only, Pledged to Strike

Only one-fourth of the unionized transportation employees of the country remain pledged to strike on Oct. 30. These are all included among the "Big Five" brotherhoods and the telegraphers. Fourteen union organizations directly concerned with railway transportation and who would be expected to go out in the case of a general strike, have voted against such action. One organization, the signalmen, has as yet not voted.

The total number of men now who stand against the strike order issued to take effect progressively on Oct. 30 approximate 1,400,000. The membership of the "Big Five" composed of the brotherhoods of railway trainmen, locomotive engineers, firemen and enginemen, the order of railway conductors, and the switchmen is about 325,000. Together with the telegraphers the number of transportation operatives who still stand instructed to carry out the strike order is about 404,000.

Anticipating that the strike order will be made effective according to schedule municipalities the country over are making plans for the mobilization of other available means of transportation for the movement of food and fuel. In New York the New York Port Authority has been charged by the governor with the co-ordination of all facilities and the preparation of a plan that could press into immediate service every state agency, should the strike take place. Gen. G. W. Goethals has been appointed to take full charge of fuel and food distribution in the New York district.

Changes Ordered in Panama Canal Administration

Following the report of the Connor Commission, consisting of Brig.-Gen. W. D. Connor, Capt. A. B. Fry, F. A. Molitor and H. A. Wilson, on the various administration problems of the Panama Canal (noted in *Engineering News-Record*, Oct. 13 p. 627), Secretary of War Weeks has ordered certain changes, but is withholding action on the major part of the recommendations of the commission. The changes ordered are in connection with the payment of rent by employees, the extension of employment of tropical labor, capitalization of auxiliary activities, and minor pay readjustments. The larger questions of open shop, etc., noted in the original report, have not yet been passed upon.

Commission Recommends Standard Gage for Australian Roads

A standard gage of 4 ft. 8½ in. for all railroads in Australia has been recommended by the Uniform Gage Commission, say cable advices to the Department of Commerce. The commission estimates that the change to that gage would entail a cost of £57,000,000.

Port Authorities Meet in Seattle

The tenth annual convention of the American Association of Port Authorities was held in Seattle, Wash., Oct. 11-14, with over a hundred in attendance. Twenty papers were presented, some merely descriptions of specific ports, but most of them taking up an engineering problem of port design or control. Besides pledging support to the War Department's investigation of port terminal charges and practices in America, the convention voted to join a movement to petition the governments at Washington and Ottawa to pass laws to overcome the floating oil menace in harbors. The petition will point out the fire danger to terminals and shipping presented by this menace. Benjamin Thompson, of Tampa, Fla., was re-elected president and M. P. Fennell, Jr., of the Harbor Commission of Montreal, continues as secretary.

Candidates Named for Am. Soc. C. E. Annual Election

The nominating committee of the American Society of Civil Engineers has selected the following candidates for offices to be filled at the annual election Jan. 18:

For president: John R. Freeman, Providence, R. I.

For vice-president: C. E. Grunsky, San Francisco, and Robert Ridgway, New York.

For treasurer: Otis E. Hovey, New York.

For directors: C. M. Holland, New York; J. J. Yates, Jersey City; F. E. Winsor, Providence, R. I.: John N. Chester, Pittsburgh; A. J. Dyer, Nashville; W. L. Huber, San Francisco.

National Societies To Discuss St. Lawrence Project

Under the auspices of the New York sections of the four national engineering societies the St. Lawrence ship canal and power project will be discussed at a meeting to be held in New York City, Nov. 14. W. L. Saunders is chairman of the committee making preparations for this event.

Gov. Henry J. Allen of Kansas will discuss the project from the standpoint of the producer of the Middle West. Dr. R. S. MacElwee, former director of the U. S. Bureau of Foreign and Domestic Commerce, will deal with the economic features of the project. H. I. Harriman of Boston will discuss "The Power and Transportation Features of the Project, Translated Into the Economics of New England and the East." Definite acceptances have been received from these speakers. Ex-Governor W. L. Harding of Iowa is also expected to deliver an address. Herbert Hoover has been invited to preside.

Am. Soc. C. E. Sections

The American Society of Civil Engineers now has 31 local sections and 34 student chapters.

Cities Lay Plans to Allay Unemployment

That cities all over the country are alive to the opportunity presented in relieving the unemployment situation through a greater activity in public works construction is indicated in reports received by Col. Arthur Woods, chairman of the committee on community, civic and permanent measures of the President's Conference on Unemployment. Though information has not come in from numerous centers, it is evident that municipalities are acting upon the recommendations made at the conference, recently closed.

Dayton, Ohio, has voted $500,000 with which to continue public work. Only citizens of that city will be given employment. Lakewood, Ohio, has disposed of about $2,000,000 in bonds through the sinking fund commission of Columbus, in order to carry forward a pavement and public-improvement program. Public work estimated to cost $1,000,000 is being carried forward in Springfield, Mass., and a representative citizens' and business man's committee examines those seeking employment.

Plans for additional work are being rushed in Buffalo, where now about $12,000,000 worth of work is being done. Portland, Me., Worcester, Mass., and Tulsa, Okla., are other cities from which communications have been received by Col. Woods.

Federal Highway Council to Cease Activities

Through a resolution passed at a recent meeting of the executive committee of the Federal Highway Council, that organization which for four years has been a factor in the discussion and working out of highway transportation problems, is to cease functioning, at least temporarily. The business depression has cut the contributions so that the council faces a deficit. A recent appeal for funds was entirely unsuccessful.

Various committees of the council are permitted to carry on research and investigations, though they are constrained from incurring any financial obligation that would fall upon the council.

Sanitary District of Chicago To Have Expert Commission

A commission of experts in sewage disposal has been employed by the Sanitary District of Chicago to recommend the most practical process of sewage disposal with special reference to the proposed north side plant on which studies have been made by the engineers of the district for more than a year. The commission consists of Harrison P. Eddy, Boston; George W. Fuller, New York, and T. Chalkley Hatton, Milwaukee. The proposed plant is to care for the sewage from a population of 750,000 expected in 1930 and 1,250,000 by 1950.

Railway Bridge and Building Association Meets

Cinder-Pit Construction, Station-Platform Surfacing, Tunnel Relining Chief Topics

Cinder-pit construction, station-platform surfacing, and relining of old tunnels were the chief subjects of technical discussion at the meeting of the American Railway Bridge & Building Association held at New York, Oct. 18-20. The attendance was larger than at any prior meeting of the association. Addresses by W. G. Besler, president of the Central Railroad of New Jersey, and L. F. Loree, president of the Delaware & Hudson Co., which made reference to the threatening strike of the railroad brotherhoods, gave the meeting a tone distinctly out of the ordinary. Expressing its support of the sentiments set forth in these addresses, the association passed a formal resolution deploring the threatened strike and reaffirming the loyalty of its members to the railroad service.

Cinder-Pit Construction

Reporting on cinder-pit construction, a committee headed by G. K. Nuss classified pits into dry pits, water pits, and pits equipped with mechanical ash removers. Representative structures of the several types were shown by drawing and view. Reference was made to the deterioration of the faces of concrete pit walls under the action of hot cinders. Some roads, it was reported, use crushed slag as aggregate in place of stone in the concrete "as a precaution against hot cinders coming in contact with the concrete while the pit is without water." Others use firebrick lining on the sides of the pits. Various types of construction of platforms of wood, earth or cinder fill, concrete, brick and asphalt, and experiences on different roads were reported by a committee headed by F. E. Weise. Experiences were shown to vary, especially in the matter of the comparative advantages of concrete and brick surface. Wear of the surface appeared to be a much less important factor than solidity of foundation and freedom from slipperiness in freezing weather. The voluminous report of the committee on "Lining Tunnels Under Traffic," W. C. Harman, chairman of committee, recorded methods used on the Southern Pacific in concreting timber-lined tunnels, on the Lehigh Valley in concreting two brick-lined tunnels, on the Canadian Pacific in lining the Rogers Pass tunnel, and on the Puget Sound in lining the St. Paul Pass tunnel shortly after construction. Further tunnel lining experiences are to be added to the report.

The new officers of the association are C. R. Knowles, president; Arthur Ridgway, J. S. Robinson, J. B. Wood, C. W. Wright, vice-presidents; C. A. Lichty, secretary-treasurer; new directors, F. C. Baylis, M. Johnson, O. F. Dalstrom.

McGill Celebrates Centennial

McGill University, Montreal, celebrated recently the hundredth anniversary of its founding with a series of brilliant functions participated in by many of Canada's most distinguished men. The central feature of the celebration was the Centennial Convocation on Oct. 13, attended not merely by the distinguished guests and graduates but by delegates from universities all over the world. Addresses were made by the principal of the University, Sir Arthur Currie; Lord Byng, Governor-General of Canada; Sir Auckland Geddes, British ambassador to the United States; Premier Taschereau of Quebec; Dr. James Rowland Angell, president of Yale University, representing sister universities, and Dr. C. W. Colby, representing the graduates. Fifty-five honorary degrees were conferred, among the recipients of the degree of Doctor of Laws being the folowing well-known civil engineers: W. W. Colpitts, of Coverdale & Colpitts, consulting engineers, New York; George H. Duggan, president, Dominion Bridge Co., Montreal; Phelps Johnson, president, St. Lawrence Bridge Co., Montreal; George F. Porter, of the Canadian Bridge Co., Walkerville, Ont.

Among the other important events of the week were the unveiling of a tablet in honor of the McGill men who were killed in the Great War, a reception of huge proportions and a meeting of the Graduate Society at which it was determined to create an endowment fund, the income to be devoted, under the society's direction, to betterment projects.

Of the many interesting smaller events of the week, was a luncheon given by the Montreal branch of the Engineering Institute of Canada in honor of the engineers upon whom honorary degrees had been bestowed. These engineers, in addition to those already mentioned, were C. V. Corless, of the Mountain Nickel Co., Coniston, Ont., and James A. MacPhail, of Queens University, Kingston.

More than 2,800 graduates registered for the celebration.

Colonel Russel Promoted

Colonel Edgar Russel, chief signal officer of the Second Corps Area, has been promoted to the rank of Brigadier-General. General Russel is now engaged on important duty in his area which composes New York and New Jersey.

Bridge Makes Big Profit

According to the August report of the Interstate Bridge Commission on the bridge connecting Portland, Ore., and Vancouver, Wash., the net income of the bridge during the month was about $800 a day over and above operating costs, salaries, and interest on bonded indebtedness. Multonomah County, Ore., gets about $15,000, and Clarke County, Wash., about $10,000 of the total profit for the year.

Hoover Sends Editors Message

Though unable to be present at the recent National Conference of Business Paper Editors in Chicago, because of the pressure of official duties, Secretary of Commerce Hoover has sent that body a message, part of which follows:

"We have indeed great problems, yet I can not but feel that if these problems are considered as human and not as material questions we can find their solution. We are dealing with questions of railways, of farms, of shops, and of instruments of commerce and industry. But in the background of every person's mind there is the fact that we are dealing not with mechanical things but that we are concerned with the problems of men, women and children. There must be in our discussion of these matters the dominating thought that the better control of economic forces is in fact simply the better comfort of the country. Those several organizations within the Department of Commerce which we have developed and set at work within the past few months are conceived in this spirit and it is a fine augury of our industrial future to know that the programs and purposes of these various departmental activities have come from our manufacturers, merchants, and engineers themselves.

"The editors of the business press have shown a fine spirit of service. Your opportunity for leadership is unique and unchallenged. Upon you rests in large measure the responsibility of the control of industrial thought and opinion in the detail of the industrial, economic, and technical problems which confront us."

Chicago Zoning Body at Work

Since its appointment July 28, the Chicago Zoning Commission has organized its twenty-two members, chosen a zoning expert, Edward H. Bennett, and now has several engineering parties in the field obtaining information on which to base a zoning ordinance, later to be presented to the City Council. H. T. Frost, assistant to Mr. Bennett, is directly in charge of the field and office work. The commission is headed by Charles Bostrom, commissioner of buildings. Other city officials are the chairman of the Board of Local Improvements, commissioner of health, corporation counsel, chairman of the Chicago Plan Commission and eight aldermen. Among the citizens at large are an architect, E. R. Graham, of Graham, Anderson, Probst & White, and two civil engineers, William Artingstall and Charles B. Duke.

Tennessee Issues Highway Bulletin

The State Highway Department of Tennessee has issued the first number of a quarterly publication called "Tennessee Highways." Its aim is to give the people of the state a clear understanding of the road-building work now in progress and planned.

State Highway Engineers Favor Fall Lettings

More Replies Received to Inquiry As to Policy for Coming Year's Construction

The letters which follow conclude the list of replies received by Engineering News-Record in response to an inquiry which it circulated:

California—Conditions in California are so different from those in the East and Middle West that the subject matter of the article referred to in your letter has little application here. The California Highway Commission is now working on the $40,000,000 bond issue for state highways, in addition to the federal-aid allotments, and this will provide a very considerable use of labor, both skilled and unskilled.

"The climatic conditions in California are such that there is very little seasonal difference in the volume of highway work in progress. It is true that in the northern part of the state for a few weeks in the winter months rains make difficult paving operations, but it is also true that in some portions of the southern part of the state highway work can be done with success during the winter months only.

"It is expected that the letting of contracts for state highway construction will be fairly continuous for two years or more from this date. When possible, for the last year or two, it has been the policy of the commission to order materials in advance of the awarding of contracts, and this plan doubtless will be continued. Where this method entails in some instances an added expense due to the necessity for moving some of the materials a second time, it often happens ultimately that a saving is made, as, when the materials are delivered in advance on the work ready for use, the commission is not subjected to claims for delay in delivery."—*By A. B. Fletcher, State Highway Engineer.*

Utah—"We are endeavoring to get all our projects shaped up for advertising and lettering at the earliest possible date. We have several projects that will be let this fall, which we are in hopes will materially benefit conditions locally. It is our plan to do everything possible along the lines that your letter suggests."—*By Howard C. Means, State Road Engineer.*

Texas—"We have no closed season for highway work in this state—we let contracts and start work during each month of the year. The movement that is now on foot in your section of the country to encourage the fall letting of highway contracts is not applicable to Texas. There is hardly a week passes during the entire year that we do not award several contracts and work on them is started immediately. I believe, however, that the adoption by the northern states of the policy you are advocating will facilitate highway work."—*By Rollen J. Windrow, State Highway Engineer.*

Tennessee—"As a matter of general policy it is the desire of the Tennessee Highway Commission to let as many contracts as possible during the fall for two principal reasons: (1) To keep as many men employed as possible during the winter, not only in the department itself, but in the contractors' organizations. (2) To insure stability of fills, as no artificial compaction of fills by means of road rollers, tampers, etc., equals the natural settlement of the soil in place in the fill allowed to remain through the winter and be acted upon by the continuous rain, freezing weather, etc.

"There are, unfortunately, some other considerations of which cognizance must be taken in our particular case, one of which is that our funds are not always available just at the proper time to let all our contracts in the fall. Therefore, we are compelled from this one practical consideration to let at least a number of our contracts at other seasons during the year. It is the policy of the department to let highway contracts at some time during the fall or early winter whenever practicable."—*By D. Q. McComb, Chief Engineer, Department of Highways.*

Idaho—"This department believes it would be advantageous to the state to let the bulk of our highway contracts in the Fall, but owing to the fact that the state treasurer has just succeeded in selling the highway bond issue and also advises that it will probably be the latter part of November before this money will become available, the amount of work let this Fall will necessarily be curtailed."—*By D. P. Olson, Director of Highways.*

Minnesota — "This department has adopted a policy of providing for an early letting on all highway construction which can be prosecuted to any advantage during the fall and winter months. In line with this policy we hope to receive bids on a large proportion of our gravel surfacing and paving construction for 1922. These lettings will be held during November and December, and definite dates will be announced as quickly as necessary details can be taken care of."—*By O. L. Kipp, Construction Engineer.*

North Dakota—Owing to the usual severe winter conditions that prevail in these latitudes it is impractical to carry on extensive road improvements during the winter months. Plans are being made, however, to place considerable gravel surfacing during the coming winter.

"The bulk of the work will be advertised during February, March and April of next year. It will be impossible to prepare plans earlier than this date as we are still awaiting the action of Congress on future federal aid. As soon as this question has been settled we will then have to make preliminary surveys and prepare plans before contracts can be let."—*By W. H. Robinson, Chief Engineer and Secretary.*

New York Engineers Hear Financing Discussed

At a joint meeting of the New York sections of the national societies of civil, mechanical, electrical and mining engineers, Oct. 19, A. B. Leach, of the New York banking firm of A. B. Leach & Co., discussed the present world situation as affecting the financing of public utilities and large engineering enterprises. He detailed the various factors which have caused such a demand for money that rates of return have been pushed to levels which, at the minute, seriously discourage the financing of public utilities and large engineering enterprises. The situation will right itself, he declared, but just now we must get the very highest production from existing plants and not expect money for new developments. He emphasized also that an essential requirement for public-utility financing was the redeeming of public confidence by utility enterprises.

Philip Cabot of Boston, member of the banking firm of White, Weld & Co., discussed the engineer's failure as a manager. His paper will be found abstracted elsewhere in this issue.

ENGINEERING SOCIETIES

Calendar

Annual Meetings

CITY MANAGERS ASSOCIATION, Spartanburg, S. C.; Annual Meeting, Chicago, Nov. 14-16.

NATIONAL MUNICIPAL LEAGUE, New York City; Annual Meeting, Chicago, Nov. 16-18.

AMERICAN ROAD BUILDERS ASSOCIATION, New York; Annual Convention and Good Roads Show, Chicago, Jan. 17-20.

The Engineers Club of Seattle has closed negotiations with the owners of the present College Club quarters to take over that building as headquarters when the new College Club building is finished. On Oct. 13 the Engineers Club of Seattle in co-operation with other engineering organizations tendered a luncheon to the visiting engineers attending the tenth annual convention of the American Association of Port Authorities. Maj.-Gen. Lansing H. Beach, Chief of Engineers, U. S. A., was the principal speaker.

The Texas Section, Am. Soc. C. E., at its annual meeting, Oct. 28-29, in Dallas, will hold an inspection tour of the Trinity Portland Cement Co. plant and of the newly finished Dallas-Ft. Worth concrete highway. After a dinner given by the Dallas Technical Club on Oct. 28 there will be an illustrated lecture on the San Antonio flood by Terrell Bartlett of San Antonio and a talk on "The Engineer and City Planning" by E. A. Wood of Dallas. On the morning of Oct. 29, there will be an inspection of the new 29 story Magnolia Building.

The Colorado Society of Engineers, at its September meeting, was addressed by Walker Young on "Problems of the Colorado River," with particular reference to the development of lands in the lower Colorado River basin by the construction of the Boulder Canyon reservoir.

The American Water Works Association, Iowa Section, will hold a meeting Nov. 1-3, in Omaha, Neb.

The Society of American Military Engineers, Philadelphia Post, at its Oct. 27 meeting will be addressed by Col. Edward Carpenter, chief of staff, 79th Division, on "Proposed Organization of the Reserve of the Army of the United States."

The Engineers' Club of Cincinnati, was addressed Oct. 20 by Dr. Burtis B. Breese, professor of psychology, University of Cincinnati, on "Personality and the Attempts to Measure It."

PERSONAL NOTES

J. M. HERBERT, of St. Louis, was elected president of the Dallas Terminal Railway & Union Depot Co. at a meeting of directors and stockholders held in the office of the company Oct. 11. Other officers are: F. W. Green, Tyler, vice-president; J. F. Lehane, vice-president in charge of traffic; E. M. Reardon, treasurer; R. T. Allen, secretary and auditor, and G. K. Warner, assistant secretary and assistant auditor.

MAJOR-GEN. GEORGE GOETHALS arrived in Dallas, Texas, Oct. 9 for the purpose of making a survey to determine the feasibility of building a large lake in the Trinity River bottoms instead of leveeing the river as originally planned. Gen. Goethals is accompanied by several engineers of his firm and is collaborating with the city, county and other local engineers.

FLOYD W. PARSONS, formerly editor of *Coal Age* and for the past two years in charge of the department entitled "Everybody's Business" in the *Saturday Evening Post*, has become editorial director of the *Gas Age-Record*.

J. P. J. WILLIAMS has resigned as editorial assistant of the American Society of Civil Engineers and has joined the faculty of Cooper Union, New York City.

W. T. CHEVALIER has resigned as general manager of the Wailes Dove-Hermiston Co., manufacturers of bitumastic compositions, New York, to become vice-president of the Brearley Service Organization which is engaged in advertising and publicity work, specializing on public relations. During the war he served as lieutenant-colonel with the 11th Engineers, one of the earliest contingents sent to France.

JAMES ZANOLIO, recently with the Colorado State Highway Commission on work near Durango, Col., is now engaged on railroad location for the Rio Grande Ry. in Utah.

E. F. KULTCHAR has been appointed district engineer, maintenance of way, of the Illinois district, Chicago, Burlington & Quincy R.R., with headquarters at Galesburg, Ill.

C. P. RICHARDSON, assistant engineer, Dakota division, Chicago, Rock Island & Pacific Ry., has been placed in charge of special work in the engineering department at the general offices in Chicago.

JOE C. THOMAS, formerly chief engineer for the John T. Milliken interests in Oklahoma, is now with the New Mexico State Highway Department on work between Socorro and San Antonio.

S. P. REES, formerly with the Pittsburgh Filter & Engineering Co., Pittsburgh, Pa., has been made manager of the municipal filtration department of the International Filter Co., Chicago.

OBITUARY

F. W. CAPPELEN, for 24 years city engineer of Minneapolis, Minn., died Oct. 16. He was born in Grammen, Norway, in 1858, and studied at the Technical School of Cerebro, Sweden, and the Dresden Polytechnic Institute at Dresden, Germany, from which he was graduated in 1880, entering the service of the Northern Pacific Ry. as a draftsman. A year later he was made assistant engineer in charge of location and construction work. For two years he was bridge engineer for the St. Paul & Northern Pacific Ry., at Minneapolis, and designed for that road the substructure of the 1,600-ft. bridge over the Mississippi at Minneapolis. From 1886 to 1893 he was assistant city engineer of Minneapolis during which time he designed and built three large bridges over the Mississippi River, one of which is the Franklin and reinforced-concrete bridge now under construction with a 400-ft. span, the longest of its type in the world. He also designed and built the North Minneapolis water-works. Since 1893, except for a 4-year period when he was engaged in private practice, he filled the position of city engineer of Minneapolis. Mr. Cappelen was a member of the committee on classification and compensation of engineers of Engineering Council and was also one of the two engineering members of the Minnesota State Board of Health.

PERRY A. HAVILAND, surveyor of Alameda County, Cal., for the past 16 years, died Oct. 12 after a brief illness. He was, until recently, senior member of the firm of Haviland & Tibbetts of San Francisco.

BUSINESS NOTES

THE CHAIN BELT CO., Milwaukee, Wis., has opened offices in Buffalo, N. Y., with T. E. Crocker, formerly assistant engineer with the New York Central R.R. at Buffalo, as district manager. He will handle the Rex line including chain, sprocket wheels, traveling water screens, elevators and conveyors.

A. T. MERCIER, formerly district engineer for the Southern Pacific lines at Los Angeles and more recently superintendent of the Oregon lines of the Southern Pacific Co., has been appointed general manager of the San Diego and Arizona Ry., with headquarters at San Diego, Cal.

THE AUSTIN MACHINERY CORP., Chicago, Ill., announces the incorporation of the Canadian Austin Machinery, Ltd., Woodstock, Ont., as sole manufacturers and distributors in Canada of the complete Austin line of earth-moving and concrete-mixing equipment.

THE WISCONSIN CONSTRUCTION CO., general contractors and engineers, will in the future be known as the Paul C. Kroeck Co., with offices in Milwaukee, Wis.

EQUIPMENT AND MATERIALS

Vertical Lift Pier Shed Door

Double-leaf vertical lift pier shed doors which permit cargo being stored close to the interior face of the door are being made by the McHarg-Barton Co., of New York. Two sample doors have just been installed on piers 17 and 18 of the Stapleton development for the City of New York.

The door consists of two leaves made of steel frames covered with crimped metal, each approximately 18 ft. wide by 10 ft. high, the upper leaf hanging above and just outside of the lower leaf with the face of the two doors overlapping and touching at the center of the door opening. As the door is opened the lower leaf rises vertically until suspended back of and touching the upper leaf, when both leaves rise together as a unit following a concave circular path until they rest suspended in a horizontal plane overhead above the cargo storage space. In this operation the door leaves are guided by curved steel channels attached to the roof trusses. This action is effected by means of an ingenious arrangement of two continuous chains attached to the two leaves of the door on either side passing over sheaves and so counterbalanced that the mechanism is always is perfect mechanical balance at all positions whether one leaf or two is being raised or lowered. It is easily operated by one man by means of a hand chain operating through a set of gears; the doors can be fully opened to their horizontal position close to the roof of the structure in from 45 to 60 sec., or closed in the same time.

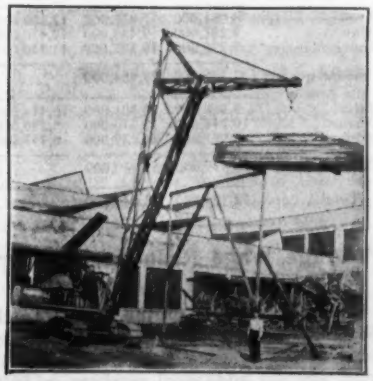
Five-Ton Bucket

A 5-ton bucket designed especially to handle coal and ore from pile to car and vice versa, though having other uses, has recently been manufactured by the Blaw-Knox Company, Pittsburgh, Pa. The bucket, which is known as the Algoma, is massively

designed to give the maximum service combined with great closing power. The closed length of the bucket is extremely small as compared to the open length. The weight of the Algoma is a little more than five tons and is capable of picking up a load its own weight.

Goose-Neck Boom

In adapting a P&H 206 crane of the type shown in the accompanying illustration to the handling of loads such as unit packages of lumber from high piles, it was found that the length of the lumber interfered with the straight or standard-crane boom. To



overcome this and eliminate much of the costly labor required to handle lengths of lumber, pipe, etc., Pawling & Harnischfeger Company developed the goose-neck boom. This boom may be lifted almost straight up without having the load interfere.

Business Side of Construction

Facts and Events that Affect Cost and Volume

Cement Production and Shipments Heavy in September

The movement of portland cement continued on a large scale throughout September, more than 11,300,000 bbl. having been shipped from mills, according to figures compiled by the U. S. Geological Survey. Shipments during the third quarter of the year were approximately 33,970,000 bbl., a record for this quarter. For the nine months ending Sept. 30, 1921, the shipments amounted to 74,045,000 bbl. which exceeds the former record volume moved in the corresponding period of 1920.

Favorable operating conditions are indicated by the large September production of 10,027,000 barrels of finished cement, which established a record for that month. The average daily production was greater than that of August, and had there been as many days in September as in August the September production would have shown the larger total.

Stocks of cement at the mills were drawn upon to supply demand during September, as is customary in the season of active demand. At the end of the month stocks of finished cement at mills were approximately 6,953,000 bbl. compared with 8,280,000 bbl. at the beginning of the month. This is about 135,000 bbl. below the average for the month of September, 1917-1921.

The production, shipments, and stocks of finished portland cement in the first nine months of 1921, are shown in the following table:

Month	Production (Barrels)	Shipments (Barrels)	Stocks at End of Month (Barrels)
January	4,098,000	2,539,000	10,300,000
February	4,379,000	3,331,000	11,400,000
March	6,763,000	6,221,000	12,000,000
First quarter	15,240,000	12,091,000	.....
April	8,651,000	7,919,000	12,600,000
May	9,281,000	9,488,000	12,450,000
June	9,296,000	10,577,000	11,150,000
Second quarter	27,228,000	27,984,000	.....
July	9,568,000	10,301,000	10,414,000
August	10,244,000	12,340,000	8,280,000
September	10,027,000	11,329,000	6,953,000
Third quarter	29,839,000	33,970,000	.....
Total	72,307,000	74,045,000	.....

Average Wage Reduction So Far This Year Is 16 per Cent

Wage reductions during August and September from 3 per cent to 50 per cent and averaging 14.9 per cent for over 400,000 additional workers in 259 industrial groups and establishments, are shown in a special digest made by the J. L. Jacobs Company, engineers and statisticians, Chicago. This average of 14.9 per cent compares with the average reduction of 15.9 per cent in wages for over 4,450,000 employees in 693 other establishments and group industries throughout the country reported during the first seven months of this year.

Summarizing the wage reductions made during the last 60 days and for the first seven months of the year, the analysis shows an average reduction of 16 per cent affecting almost 5,000,000 workers in 952,000 establishments or industrial groups in practically every key industry in the country.

By deducting 1,879,000 railroad and express employees who received an average wage reduction of 12½ per cent, the average reduction for the other 950 groups and establishments is 18.1 per cent.

In the buildng trades the more important changes reported included wage reductions in Chicago, Detroit, Dayton, Ohio; Fort Wayne, Ind.; California, and Westchester County, New York.

Unemployment As It Affects the Building Trades

Climatic Conditions Governing Factor —Three Winter Months Hardest

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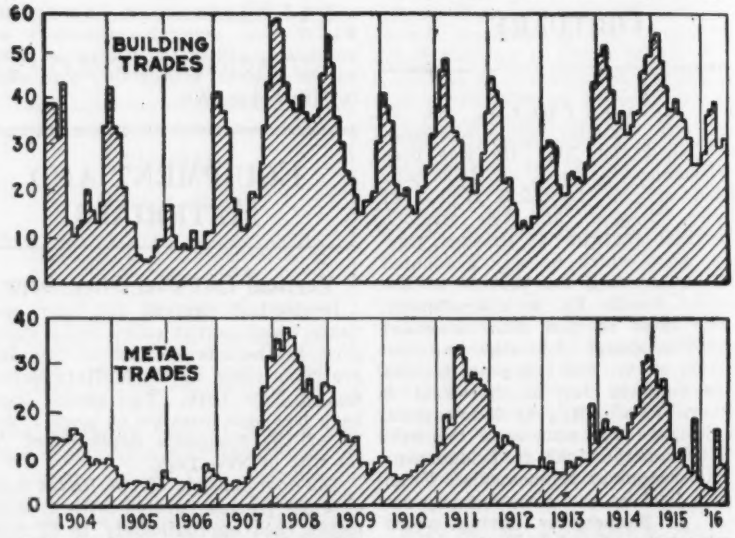
The unemployment existing from year to year in the building trades is shown in one of the charts reproduced herewith as presented to one of the committees of the President's Conference on Unemployment. The data from which this chart was compiled were taken from the state of New York and, while not purporting to apply in exactly the same ratios to the entire country, are nevertheless believed to be in many respects fairly typical of the ups and downs of the construction industry.

A study of the building unemployment situation as shown by certain charts and figures kept over a long period of years may reveal in time respects in which seasonal lack of work can be reduced by making some provision for other work for building employees during slack periods. Such a suggestion was made by the economic advisory committee of the unemployment conference. Until this is done, the winter will mean in all northern cities a marked curtailing of construction work and increased idleness due to that cause. The present year, however, is clearly an exceptional one which requires unusual effort to assuage what may become an abnormally high unemployment season.

As compared with the metal trades, the building trades curve shows a



PERCENTAGES OF UNEMPLOYMENT OF ORGANIZED LABOR IN THE BUILDING AND METAL TRADES—NEW YORK STATE

American Locomotive Company Receives Large Order

Recent orders received by the American Locomotive Company include the following: For the Chilean State Railways, 20 broad gage Mikado type engines, 195 tons each; for the Chicago, Rock Island & Pacific R.R., 14 Mikado type engines, 168 tons; for the Mississippi Central, two Mikado type engines, 89 tons; for the LaCrosse & Southeastern R.R., one ten-wheeler, 67 tons. The firm has also recently finished 47 engines for the Pekin-Suiyuan, 7 of which are the largest engines ever exported from the United States. The placement of an order by the Chicago, Rock Island & Pacific for 14 Mikado type engines is one of the largest domestic orders placed in some time.

much greater fluctuation and a wider range of unemployment. One interesting feature of the chart herewith is the low percentage of unemployment during the winter of 1905-6, and again the winter of 1912-13. The explanation which at once suggests itself, that this was due largely to the mild winters of those years, is confirmed by reference to the files of the United States Weather Bureau. During the winter of 1905-6 the entire period from January to March was mild enough to allow the carrying on of construction almost continuously.

Figures from which the accompanying chart was made were collected for more than a dozen years and extend over a long enough period to justify the conclusion that they represent a clearly marked movement in the industry. No figures were collected after the middle of 1916 inasmuch as funds were lacking. How valuable definite figures would be for the current year, collected consistently by a responsible statistical body, and comparable with previous years, is manifest. Knowledge of the extent of existing unemployment in the building and other trades would assist in measuring the extent of the problem confronting us this winter and taking intelligent action regarding it. Relief for unemployment could thus be expedited and the improvement of the general business situation would be hastened.

It is apparent that a thorough study is necessary before the problem of unemployed building trade mechanics can be handled. As yet little attention has been paid to discovering what occupations will dovetail with construction and furnish work from December to March. This is a field in which enterprising employers of building labor or practical students of unemployment problems can perform a service to the country by developing a plan which will eliminate some of these seasonal fluctuations.

Employment in Selected Industries Quickens

Comparing the figures of September, 1921, with those of identical establishments of September, 1920, the Bureau of Labor Statistics finds increases in the number of persons employed in eight industries and decreases in six industries. The most important increase, 59.2 per cent, appears in the woolen industry, while an increase of 18.4 per cent is shown for boots and shoes, and one of 13.9 per cent for cotton finishing. Decreases of 42 per cent, 35 per cent, and 31.6 per cent appear in iron and steel, car-building and repairing and paper making respectively.

Comparative data for September and August of this year show that in eleven industries there were increases in the number of persons on the payroll in September as compared with August, and three decreases.

New York Construction Materials and a Railroad Strike

New York is so favorably situated that even a serious railroad strike will not keep out necessary supplies. With barge and lighter service supplementing, the railroads terminating in Jersey City and Manhattan, New York producers and dealers believe that there will be no serious interruption in supplies of construction materials. Producers and dealers have foreseen the possible stringency as follows:

Steel—A large dealer advises he has ample warehouse stocks in Jersey City, which will be shipped to the metropolitan district by trucks, except in the contingency of a ferry tie-up. Of course mill shipments will be out of the question except in the event of emergency operation of the railroads.

Sand and gravel—Unlimited supplies may be shipped by water.

Crushed Stone—As stone is shipped by water the only possibility of shortage can come from a protracted strike cutting off fuel supplies for tow-boats. An important producer advises that he has two months' supply of coal and one month's supply of powder.

Common Brick—There is no reserve stock, but the kilns supplying New York district can supply any demand on short notice by barge from the Hudson River district.

Hollow Tile — Reserve stocks are large and can be shipped from Perth Amboy by truck, coming in either by New Jersey or Staten Island ferries.

Cement—Liberal supplies already in New York warehouses will be augmented by shipments from both the Lehigh and Hudson River districts, the latter predominating. Supply is safe except in the case of a protracted strike.

Lime — Warehouse stocks are heavy and can be reinforced by water shipments.

Steel Pipe — Heavy warehouse stock will afford ample supply for a reasonable length of time.

Industrial Association Idea Spreads on Pacific Coast

The Industrial Association of San Francisco, which was one of the outgrowths of last summer's building strike in that city has rapidly gained popularity as the principles for which it stands have been put into effect. Reference to this organization appeared in *Engineering News-Record* Sept. 8, 1921, p. 427. Early in October reports from other Pacific Coast centers indicated that the industrial association plan now in effect in Los Angeles and San Francisco is more or less definitely being considered in other Coast cities.

The program being followed is that of giving equal consideration to all three interests involved in industrial relations, namely: The public, capital and labor. Union organization is not discouraged in any way, but union activities that work contrary to public interest are vigorously opposed.

Railway Wins Pay Cut Order From Labor Board

The United States Railroad Labor Board has authorized a 20 per cent wage reduction for engineers, motormen, firemen, conductors, and brakemen of the Electric Short Line Railway Co., Chicago. In ordering the cut the Labor Board took into consideration, for the first time in its deliberations, the financial condition of the petitioning railway. It was pointed out that unless a reduction was allowed, the road must become bankrupt. The reduction was made retroactive to Oct. 16.

To Start Railroad Work in Texas Costing $425,000

The first work on roadbed improvements, totaling $425,000 to be made by the M. K. & T. Ry. Co. in Texas will begin Nov. 1 with the laying of new rails between Hillsboro and Waco and continue until Jan. 1. About $25,000 of the expenditure will be for flood damages incurred during the recent San Antonio storm. A meeting of the district superintendents of the maintenance of way department was held in Dallas Oct. 10 with W. M. Whittenton, assistant chief operating officer, presiding.

Average Earnings of Factory Employees in New York

According to figures compiled by the chief statistician of the New York State Department of Labor, the average weekly earning of New York state factory workers declined 45c. during July. The July average weekly earning in the factories as a whole was $25.26, which is $3.67, or 13 per cent, less than the record average earning of last October. The rise in weekly earnings since June, 1914, is 99 per cent. Reductions in working time were again responsible for the larger part of the decrease in average earnings.

Increased Demand Further Reduces Idle Cars

According to reports just received by the car service division of the American Railway Association, increased demand for transportation facilities has resulted in a further reduction in the number of idle freight cars. For the period from Oct. 1 to Oct. 8 this decrease amounted to 29,450 cars, making the total idle freight cars 345,920. Of this number 202,950 were in need of repairs and the remaining 142,970 were in good order and could be placed in service immediately if traffic conditions warranted. This figure compares with 172,420 surplus freight cars in good order on Oct. 1.

Residents Get Preference on New Jersey State Work

Residents of the state will be given preference when it comes to the employment of skilled and unskilled labor on state work of the Department of

Institutions and Agencies, State of New Jersey. This announcement has been made by Commissioner Burdette G. Lewis, and is in keeping with a determination on the part of the state board of control to contribute as far as possible to the solution of the unemployment problem in New Jersey.

British Columbia Prepares For Winter Road Work

The British Columbia Government at Victoria has sold government bonds to the value of $2,000,000 to provide money for active road construction during the winter months, Hon. John Hart, minister of finance, announces. The bonds are six per cent, run for 25 years, and are payable as to interest and principal in Canada only.

Seattle Building Increases

Substantial increases in the volume of construction undertaken in Seattle during September were noted, and indications point to an increasing volume of business in the construction field during the balance of the year. During the month of September, permits valued at $1,355,430 were issued, something like $500,000 higher than for September of last year.

Dallas County Rejects Bids on Road Bonds

The Dallas County, Texas, Commissioners' Court has recently rejected a number of bids made for the second series of road bonds amounting to $2,700,000 because the court did not believe that the best price offered was either what the bonds were worth or all that could be gotten for them. The first series, disposed of last year, amounted to $2,100,000, bore 5 per cent interest and sold for a premium amounting to almost 7 mills. The series now offered for sale bears 5½ per cent and the best bid offered was 94½c.

Weekly Construction Market

THIS limited price list is published weekly for the purpose of giving current prices on the principal construction materials, and of noting important price changes on the less important materials. Moreover, only the chief cities are quoted.

The first issue of each month carries complete quotations for all construction materials and for the important cities. The last complete list will be found in the issue of October 6, the next, on November 3.

Steel Products:	New York	Atlanta	Dallas	Chicago	Minneapolis	Denver	San Francisco	Seattle	Montreal
Structural shapes, 100 lb	$2.88	$4.00	$4.00	$2.88	$3.16	$3.75	$3.70	$4.00	$4.00
Structural rivets, 100 lb	3.70	5.25	5.50	3.68	4.15	4.25	5.50	—4.50	6.50
Reinforcing bars, ¾ in. and larger, 100 lb	2.78	3.20	3.50	2.78	3.18	3.57½	2.35	3.75	3.75
Steel pipe, black, 3½ to 6 in. lap, discount	51%	52.65–5%	45%	65½%	58.9–5%	38%	51.8%	55%	5%
Cast-iron pipe, 6 in. and over, ton	45.30	40.50	54.30	—42.60@44.10	47.80	52.00	50.00	—53.00	60.00
Concreting Material:									
Cement without bags, bbl	2.40	—2.60	2.55	1.97	2.26	3.10	2.84	3.10	3.10
Gravel, ¾ in., cu.yd	2.00	—2.00	2.25	1.65	—1.50	2.50	2.25	1.50	1.50
Sand, cu.yd	1.25	1.35	2.25	1.65	—.50	1.10	1.50	1.50	1.25
Crushed stone, ¾ in., cu.yd	1.80 to 1.90	2.25	3.20	1.60	2.25	3.50	2.25	3.00	2.10
Miscellaneous:									
Pine, 3x12 to 12x12, 20 ft. and under, M.ft	45.00	38.00	35.00	48.00	36.00	50.00	29.00	24.00	120.00
Lime, finishing, hydrated, ton	16.99	19.00	25.00	18.00	29.00	30.00	—22.00	27.50	21.00
Lime common, lump, per bbl	3.69	1.60	2.75	1.40	1.40	2.95	1.90	2.75	15.00
Common brick, delivered, 1,000	—18.40	11.00	12.72	11.00	17.00	14.00	18.00	14.00	16.00
Hollow building tile, 4x12x12, block	Not used	.14	.124	.0821	.092	.09	.12½	.10	.15
Hollow partition tile 4x12x12, block	.11370	.14	.124	.0657	.092	.10	.14½	.11	....
Linseed oil, raw, 5 bbl. lots, gal	.73	—.85	.93	—.80	—.76	—.92	.83	.79	.90
Common Labor:									
Common labor, union, hour	.75@.80	.35	.....	.72½	50	.50@.55	.75	.50@.60	....
Common labor, non-union, hour	.....	.20	.35@.45	.35@.40	.50	.35@.40	.50@.55	.50	.25@.30

Explanation of Prices—Prices are to contractors in carload lots unless other quantities are specified. Increases or decreases from previous quotations are indicated by + or — signs. For steel pipe, the prevailing discount from list price is given: 45-5% means a discount of 45 and 5 per cent, 45@50 means a range of 45 to 50 per cent. Charge of 15c. per 100 lb. for cutting reinforced steel into 2-ft. lengths or over. **New York** quotations are delivered except tiles, which are "on trucks." Common lump lime per 280-lb. net; both lump and hydrated quoted f.o.b. cars New York. Sand gravel and crushed stone are quoted alongside dock. Cement delivered to contractors on job. **Chicago** quotes hydrated lime in 50-lb bags; common lump lime per 180-lb. net. **Minneapolis** quotes on fir instead of pine. Brick and hollow tile delivered. Cement on cars; $2.45 delivered. Gravel, sand and crushed stone quote at pit. We quote on brown lime per 180-lb. net; white is $1.70 for Kelly Island and $1.65 for Sheboygan. Common labor not organized. **Denver** quotes cement "on tracks"; gravel and sand at pit, stone on cars, lime, brick, hollow tile and lumber on job. Tile price is at warehouse. Linseed oil, delivered. **Atlanta** quotes sand, stone and gravel per ton instead of cu.yd. Common lump lime per 180-lb. net. **Dallas** quotes lime per 180-lb. bbl. Steel, cast-iron pipe and crushed stone f.o.b. cars, other materials delivered. **San Francisco** quotes on Heath tile, 5½ x 8 x 11½. Prices are all f.o.b. warehouses except C. I. pipe, which is mill price plus freight to railway depot at any terminal. Lumber prices are delivered "at ship tackle in San Francisco ex mill." **Seattle** quotes on Douglas fir instead of pine; and on lime in paper bags. **Montreal** quotes sand, stone, gravel and lump lime per ton. Cement, lime and tile are delivered; sand, gravel and stone, on siding; brick f.o.b. plant; steel and pipe at warehouse. Cement price is in Canadian funds, exchange with the United States being 14 per cent at present. Bag change is 80c. per bbl. Discount of 10c. per bbl. for payment within 20 days from date of shipment.

Changes Since Last Week

Steel plates are quoted at the Pittsburgh mills at $1.60@$1.65 for small tonnages; but business has been done as low as $1.50@$1.55 per 100 lb. Structural shapes are quoted at $1.50@$1.65 as against last week's price of $1.60@$1.75 per 100 lb. Reinforcing bars are quoted at $1.50 with small tonnages selling at $1.60@$1.65 per 100 lb. Mill shipments, New York, of structural steel shapes and plates are quoted at $1.98@$2.13; bars at $1.88@$2.03 per 100 lb. Minneapolis quotes mill shipments of steel shapes at $2.51 via all rail; $2.45 per 100 lb. by lake and rail. Reinforcing bars are quoted in Seattle at $4.50 as against $5 per 100 lb.

Decreases in cast-iron pipe are reported in two cities. Seattle quotes $53 as against $55 and Chicago $42.60@$44.10 as compared with $45.60 per ton.

Atlanta reports a drop of 9c. per bbl. in the price of cement. Gravel prices have declined 50c. in Minneapolis and 13c. per cu.yd. in Atlanta. Minneapolis quotes sand at 50c. as against $1 per cu.yd. at pit. Hydrated finishing lime is quoted at $22 as compared with $25.40 per ton the previous quotation.

Common brick is quoted in New York at $15 wholesale as against $15.50@$16; $18.40 per thousand delivered.

A decline of 1c. per gal. in the price of linseed oil is reported in Denver, Atlanta and Chicago; while Minneapolis quotes a drop of 5c. per gal. in 5 bbl. lots.

Building crafts in Colorado Springs, Col. are reported as having ceased work October 20 when the wage reduction, approved by the State Industrial Commission, was placed in effect.